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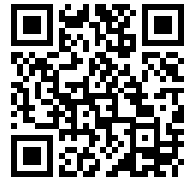

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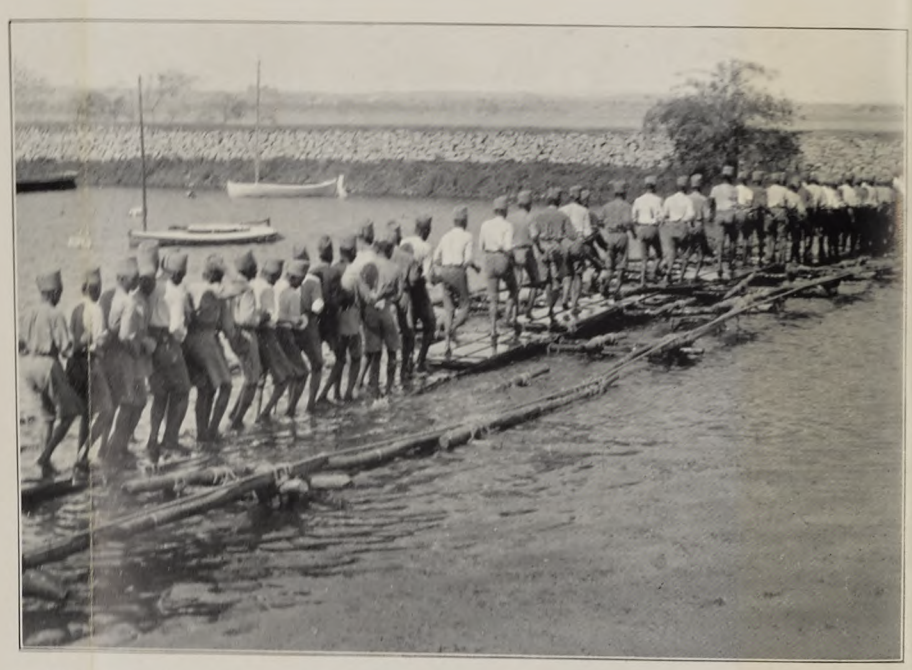
INFANTRY FOOTBRIDGE.

1.—Single Raft ready to Launch.



3.—Bridge under excessive and varying Load—Men Doubling (one man per foot-run in thickest part).

2.—180' Bridge complete with Raft Commanders standing each in centre of his Raft, to show Rafts.

4.—Bridge half Loaded, half not Loaded, showing recovery from 3.

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INFANTRY FOOTBRIDGE.

By Bt. Major R. L. McClintock, d.s.o.

In the July, 1907, number of the *R.E. Journal* an article was published entitled "Some Ideas on Field Engineering." In this (*vide* para. 8 and *Plate* II., *Fig.* 4) details were given of a floating footbridge—to carry infantry in single file at 4′ distance—composed of 108-gallon casks, light 18′ spars and 10′ planks.

(In case present readers have not the volume in question immediately at hand, the drawing is reproduced in *Fig.* 1).

From the first, the idea appealed strongly to this unit. A light and easily constructed cask footbridge might be very useful on service, and the *Manual*, Part III., contains no information on the subject. Further, such a bridge makes a little material go a very long way, and detached companies of Sappers & Miners are not overburdened with fieldworks stores. Gaps over real water, convenient to cantonments and of width small enough to be spanned with the exiguous material at the disposal of a detached company in the form of the ordinary heavy floating bridge, are rare in India. When water at all is available it is usually of considerable width, and when it is a case of possibly a 160′ wet gap, it is far more interesting to the officer and aquatically instructive to the man to cross it in reality with a footbridge, than to use the equivalent in material in making some 20′ of heavy bridge leading nowhere, and consequently somewhat lacking in conviction to the unimaginative native mind.

The cask footbridge idea was accordingly attacked with enthusiasm by the S. & M. at Secunderabad, as they were in the above position of having a wet gap of about 160′ at their disposal, together with a number of 54-gallon casks quite inadequate to cross it with the ordinary heavy bridge. Experience soon showed that the type suggested was not entirely satisfactory in details—for one thing, 108-gallon casks are not obtainable in India—and experiments followed to see if it could not be improved upon and adapted to local conditions.

As a result of these experiments, which have continued on and off for a matter of a year and a-half, I can now offer the details of what we consider an improved version.

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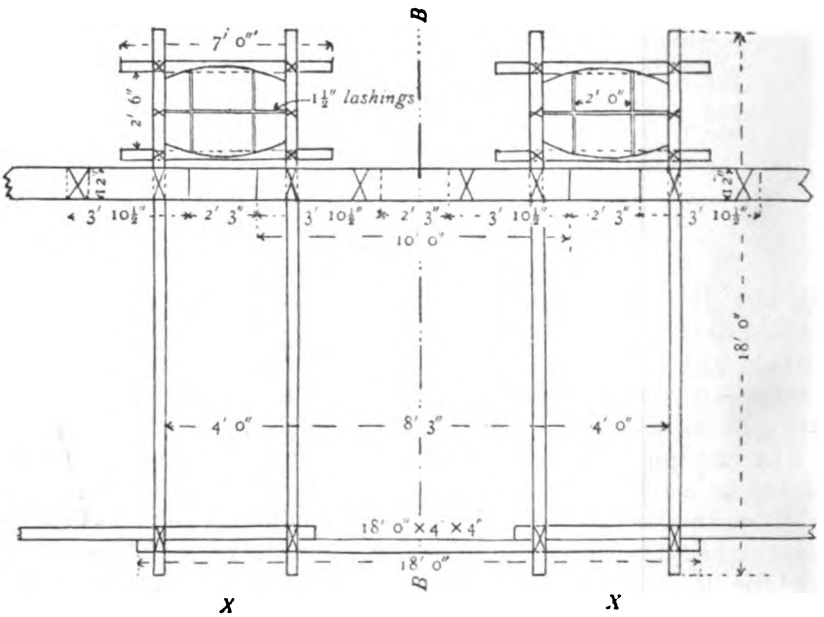
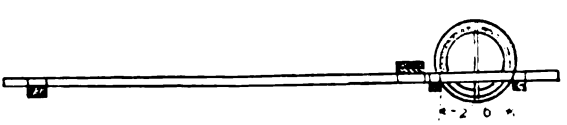


PLAN OF ONE BAY.

ELEVATION (looking from XX)



SECTION B.B.

FIG. 1.

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The 1907 pattern, from which we started, suffered from the following disadvantages :—

I. The lashings, as shown in the figure, are very difficult to put on properly so as to make a good job of it, and take an inordinate time. To describe the deficiencies of a fancy lashing on paper is an almost impossible task, but anyone who tries to reproduce the above figure for himself will very soon discover what they are.

II. The roadway is put on so low with reference to the casks, that only about half the buoyancy of the latter can be utilized before it sinks under water. This prevents the bridge being loaded up to anything like its full capacity.

In the "Secunderabad" pattern (described later) it is claimed that :—

I. The lashings are perfectly simple (being ordinary "square lashings"), and it is as easy to make a good and tight fit of the cask to the gunnels as it is in the ordinary heavy cask pier.

II. The roadway being on the top of the casks, the last available pound of buoyancy can be utilized, and a much heavier load carried. For instance, the 1907 pattern will only carry one man per 4′, while the "Secunderabad" pattern, with but 18 lbs. more buoyancy per foot-run, will carry more than twice as many.

The following table will show at a glance the relative points of the two patterns in a span of 120′ :—

Span.	Pattern of Bridge.	Materials Required.							Details.			Remarks.
		Casks.		Timber.			Lashings.					
		108-Gall.	54-Gall.	18″×4″×4″ (*a*). 15″×3″ (*b*).	4′×4″×4″ (*a*). 4′×3″ (*b*).	10′ (*a*), 11′ (*b*), Chesses.	2″×48′	1¾″×36′	Interval between Piers.	Buoyancy per Ft.-Run. lbs.	Men carried on 120′ Span.	
120′	1907 (*a*)	10	—	31	20	21*	80 (approx.)		12′	90	30	From *R.E.J.* '07.
	Sec'bad (*b*)	—	24	50	24	12* or 36†	64	36	10′	108	72	From Expermt.

* Roadway, one plank wide.

† ,, three planks wide (as usually made, and as shown in diagrams and photos).

Further advantages claimed for (*b*) are ease and celerity of construction, and greater stability in the water.

The bridge shown in the photos was made against time at an

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inspection, and the following were the times for the various operations :—

Forming rafts on shore	19 minutes.
Launching and warping to place	11 „
Connecting up rafts and completing ...	19 „
Total, from command "Prepare to Form Piers" till bridge open for traffic	*49 minutes.*

Span, 160′. Working party, 8 N.C.O.'s and 96 men.

The bridge was made from one end only, and the approaches at that end were bad and the bank steep.

As a test the working party was then sent across the bridge at the double. This produced no effect on it. Next, to simulate the effect of a strong current, a rope was attached to the middle of the bridge and hauled on by all the men. The upstream anchors of course dragged ; then the attachments of the bridge to the shores carried away ; the bridge assumed a nearly semi-circular form, and was towed downstream without any further damage. It was finally straightened again in about five minutes by merely hauling on the upstream anchor cables, and was as good as ever. It was perfectly passable at any time, even when semi-circular.

Note.—Between the photos and the diagrams a slight discrepancy may be observed as regards the chesses. This is due to the fact that we had not enough 11′ chesses to complete the entire bridge as in the diagram, and so had to make some rafts with 7′ chesses instead. In such cases two overlapping 7′ chesses took the place of one 11′ ; there was no other difference.

LIST OF STORES REQUIRED FOR EVERY 20′ OF CASK FOOTBRIDGE.

20′ = ONE 10′ RAFT + TWO HALF INTERVALS OF 5′ EACH.

Casks, 54-gallon	4
Gunnels (round spars about 15′ × 3″ diameter) ...	4
Tie baulks („ „ „)	4
Cross pieces (4′ lengths of same)	4
Chesses, 11′	6
Lashings, 2″—48′	8
Lashings, 1½″—36′	6

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It greatly facilitates quick work, if before commencing operations the gunnels and tie baulks can be marked with chalk, paint, or a notch at two points 10′ apart and equally distant from the ends, so as to give distance apart of casks, bung to bung, in piers and rafts.

The accompanying drill, compiled as far as possible on the lines of "Cask Bridging" in the *Manual*, together with the two diagrams, describes the method of construction fully.

Forming Rafts in Slow Time.

Twelve men and one N.C.O. form one "Raft Detachment." The working party falls in, with the water on its left, in column of detachments in double rank, the N.C.O. (Detachment Commander) on the left of the front rank.

TELL OFF YOUR DETACHMENTS FROM THE FRONT. — The Commanders take a pace to their front, turn to the right, and tell off their detachments :—

No. 1 Raft.
No. 2 Raft, etc.

FRONT RANKS "A" PIERS.

REAR RANKS "B" PIERS.

NO. 1 RAFT, STAND AT EASE.

NO. 2 RAFT, STAND AT EASE.

"A" PIERS, ATTENTION.

"B" PIERS, ATTENTION.

FROM RIGHT OF EACH DETACHMENT, NUMBER. — Both ranks of each detachment number off from 1 to 6.

NOS. 1 & 6 GUNNEL MEN, REMAINDER SLING MEN.

GUNNEL MEN, PROVE.

SLING MEN, PROVE. — On each man's number being called he will lift his left arm to the full extent above his head, and keep it there till next number (or down) is called.

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I.

PREPARE TO FORM PIERS.

The gunnel men (1 & 6) bring up one gunnel each and lay them down at right angles to the bank, about 3′ apart.

Nos. 2 each bring up four 48′ 2″ lashings (slings), uncoil them, and lay one at each end of each gunnel.

Nos. 3 bring up two cross pieces each and lay them in between each pair of gunnels.

Nos. 4 and 5 bring up one cask each and place them, bung up, 10′ apart, bung to bung, between the ends of each pair of gunnels.

II.

Nos. 1 & 6 then bring up one tie baulk each and lay them down at right angles to the ends of the gunnels, between themselves and their corresponding numbers of the other pier.

Nos. 2, 3, 4, bring up one 11′ chess each and lay in two piles parallel to the tie baulks, and on the side of them and the raft nearest the store.

No. 5 bring up three 36′ 1½″ lashings each and place on top of the piles of chesses.

Each detachment then falls in on its two piers, A & B, Nos. 1 & 6 at opposite ends of the gunnels; Nos. 2 & 3, 4 & 5, at opposite ends of the casks, the whole facing inwards.

GUNNELS.

Nos. 2 & 4, 3 & 5, lift up the gunnels and place them on the casks between the second and third hoops, with the 10′ marks in line with the bungs.

Nos. 1 & 6 hold the ends of the gunnels to steady them while the slings are being fixed.

SLINGS.

Nos. 2, 3—4, 5, each tie one end of each sling to the end of each gunnel with a clove-hitch vertically above the swell of the cask.

Nos. 2 & 4 then place the two cross pieces across the gunnels on the opposite side of the casks from the clove-hitches, and above the swell of the casks.

The sling men then pass each sling round underneath the cask nearest to it, haul taut as possible, and square-lash the cross pieces to the

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gunnels where they cross, taking two turns of lashing and two frapping turns, and then making fast each sling with a half-hitch on the end of its cross piece.

TAKE FRAPPING TURNS. The sling men, with the remainder of each sling, take two complete frapping turns in opposite directions round the four standing ends formed by the two slings of each cask and hold on.

PREPARE TO ROCK AND HEAVE. The sling men take a short pace backwards, place their left feet on the gunnel opposite them, and hold the end of the sling taut.

ROCK AND HEAVE. The sling men, assisted by Nos. 1 & 6, rock the piers from side to side, and take in as much slack as possible of the frapping turns of the slings.

STEADY. The sling men remove their feet from the gunnels, holding slings taut.

MAKE FAST. The sling men make fast each sling to its own gunnel with a half-hitch close to the original clove-hitch from which it commenced. This must be done without the slings being allowed to slacken. The casks should now be quite tight up against the gunnels.

CHESSES. Nos. 2, 3—4, 5, lift three of the chesses on to the middle of each pair of gunnels, placing them at right angles to the gunnels, with half the chess on each side of the pier. The three chesses to be parallel and a couple of inches apart, to leave room for the lashing to pass between them.

Nos. 1 & 6, assisted by the other numbers as may be necessary, then each take one $1\frac{1}{2}''$ lashing and attach it with a clove-hitch to each gunnel, close up to the chesses, and on his own side of them. These lashings are then each carried over the nearest chess, then under the gunnel, then over the centre chess, then under the same gunnel, then over the last chess, and finally made fast each to its own gunnel with a clove-hitch. The remainder of each lashing is then coiled up and left; it is again used later in the junction with the adjacent piers.

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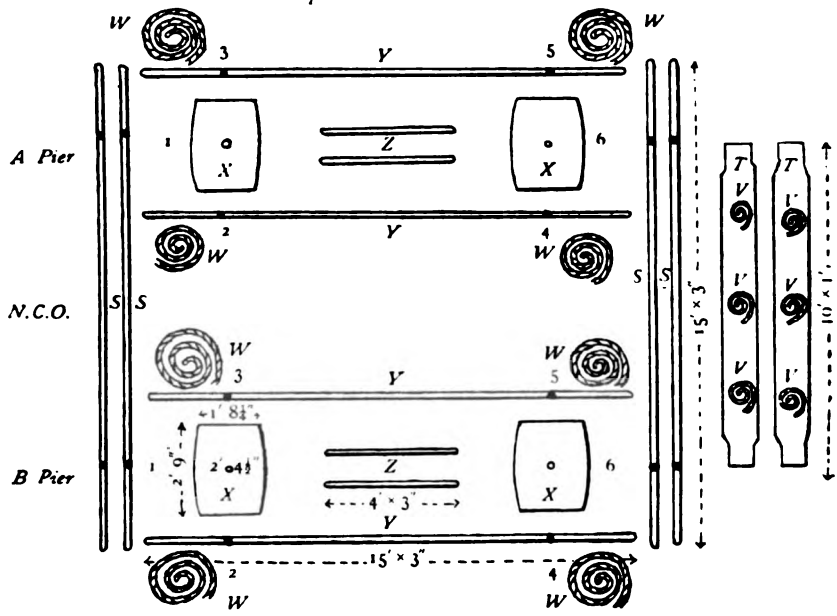
Diagram of Stores as they should be laid out on Command "Prepare to Form Pier."



S	*Tie Baulks* 15′ × 3″	(4)	*X*	*Casks*, 54 *galln.*	(4)
T	*Chesses*	(6)	*Y*	*Gunnels* 15′ × 3″	(4)
V	1½″, 36′ *Lashings*	(6)	*Z*	*Cross Pieces* 4′ × 3″	(4)
W	2″, 48′ ,,	(8)			

The piers are now complete, and it remains to form them into rafts.

MAKE SQUARE. The N.C.O. in charge of each detachment then sees that the two piers are the correct distance apart and square by measuring the diagonals, bung to bung.

FORM RAFT. The two Nos. 1 then lift up one tie baulk between them and place it across the ends of the four gunnels, outside the clove-hitches of the slings, with the marks on baulks and gunnels corresponding. The two Nos. 6 do the same at the other end of the raft.

The sling men of each pier then lash the tie baulks to the gunnels where they cross each other, using the remainder of the slings and finishing off with a clove-hitch.

Nos. 1 & 6 meanwhile lash the inner ends of the chesses of each pier together where they overlap in the centre of the raft. The remainder of the two 36′ lashings used for attaching the chesses to the two inner gunnels of the raft is sufficient for this.

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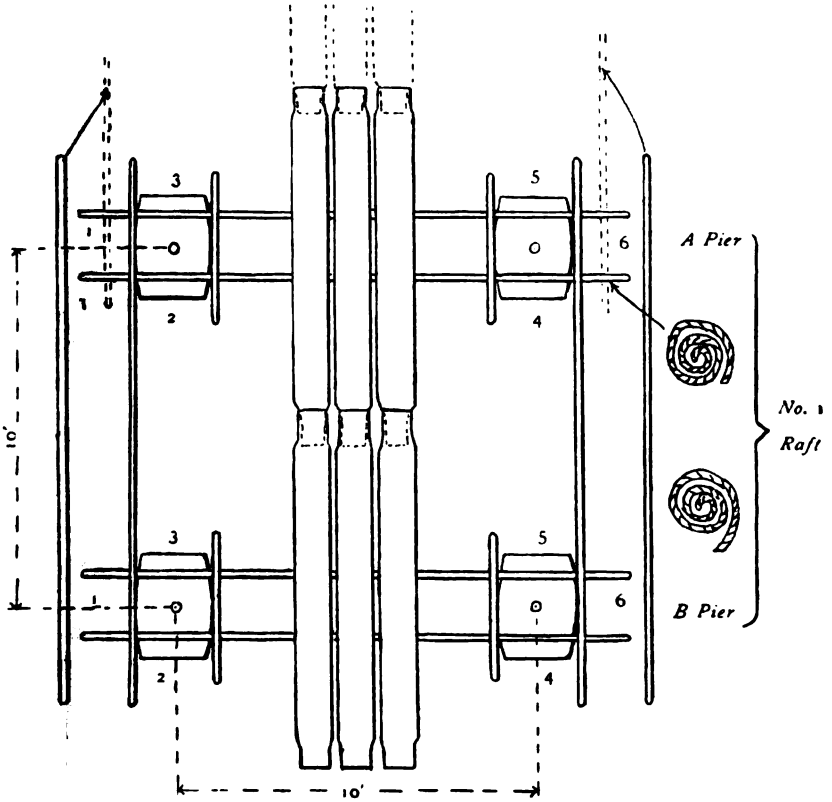
Diagram of one Complete Raft of Cask Footbridge.



(*Lashings omitted for clearness*).

The raft is now complete, and ready for launching to take its place in the bridge.

PREPARE TO LIFT —LIFT. The 12 men of the raft detachment take posts at the corners of their respective piers, and lift on word of command, carrying the raft on their shoulders.

LAUNCH. When the raft is in the water, all men leave it except the N.C.O. and the four gunnel men. The latter take posts one at each corner of the raft with a boathook or oar. The N.C.O. sees that the two remaining tie baulks and two remaining 1½″ lashings are placed on the raft, takes his place in the centre, and gives the word to shove off.

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The four gunnel men haul, pole, or row the raft into its final position in the bridge, and attach it to the previously placed raft, and at a distance of 10′ from it, by means of the two tie baulks and two lashings, which are on the raft.*

They then assist the following raft to attach itself to their raft in a similar manner.

The outer tie baulks of the raft at each end of the bridge are similarly lashed to two pickets driven into each bank.

The remainders of the 36′ lashings which were left on the outer gunnels of each raft are now used to connect the overlapping ends of the chesses of each raft with the chesses of the rafts on each side of it.

The operations are now complete, with the exception of placing anchors and cables and dressing bridge.

* In cases where there is not much current an expeditious method of "rafting" is to haul a 3″ rope as taut as possible across the gap (buoyed at intervals if necessary), and attached to holdfasts in each bank.

When the first raft is launched the gunnel men "warp" it across at once by means of this rope to its final position at the far bank. The remaining rafts follow in succession in like manner and attach themselves each to its predecessor, until the bridge is completed to the near shore.

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SHEERNESS WATER SUPPLY.

We are indebted to the Director of Fortifications and Works for the following interesting Reports by Colonel T. J. W. Prendergast and Lieut.-Colonel B. E. Morony, R.E. :—

Early History.—Since the year 1782, and possibly before, the garrison of Sheerness has drawn its water from artesian wells, from which the area enclosed by the land front of the defences, and now containing the garrison recreation ground, hospital, etc., derives its name of the Well Marsh.

At this point the London clay is found at the surface, and extends to a depth of 338′, below which are tertiary beds of various coloured sands, some of them mixed with loam or clay, and known as the Oldhaven, Woolwich, Reading, and Thanet beds (see *Plate, Fig.* III.).

The latter rest, at the depth of 500′, on a chalk bed, the depth of which has never been ascertained.

The old well—or No. 1, as it is now called—is said to have been dug in 1782, but there are no records to show whence water was obtained previous to that date. Rain water must have been used, supplemented by shallow wells.

It is probable that experience at Queenborough Castle, about 2 miles off, told the engineers of the day that, in order to obtain water at Sheerness, it would be necessary to pierce the London clay, which would be found to be over 300′ thick. At any rate, a well 6′ in diameter, and brick lined, was dug through the London clay, and it is evident that when the excavation had nearly reached the water-bearing sands, the remaining layer of clay was pierced, and water rushed into the well and must have risen nearly to the surface.

There are no records to show whether the well was pumped out to allow of the completion of the brick steinings to the base of the clay ; but this seems highly improbable, as for many years water was drawn by a bucket worked by hand and horse-power, and it is much more likely that work was stopped as soon as water entered the bottom of the well.

Difficulties caused by Sand.—9″ Bore Pipe, No. 1 Well.—In 1855 it was found that sand had filled up the lower part of the well to a height of 110′ from the bottom, and that the supply of water was diminishing, and it was decided to drive a 9″ bore pipe through the sand in the well to the water-bearing strata below. This pipe was carried from 167′ to 480′ below the surface, that is to say, it penetrated 142′ of the water-bearing sands.

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First Steam Pump.—In 1858 a single throw pump of 6″ diameter with 3′ stroke was fixed in No. 1 Well, the suction being 167′ below the surface. This pump was driven by a vertical high-pressure non-condensing engine, by spur and pinion gearing.

In 1861 the sand had risen 12′ higher in the well, and the water level in July and August was 131′ below ground.

Enlargement of No. 1 Well.—In 1862 it was decided to clear the sand out of the lower part of the well and enlarge a portion of the well so as to form a larger reservoir; and recent operations have shown that the brick steining was domed out from 6′ to about 9′ diameter, from 165′ below the surface to a depth of 265′ (see *Plate, Fig.* I.).

In 1864 the well was still giving trouble, sand was causing much damage to the pumps, and water was short. From a series of observations made, extending over several months, it was found that the sand in the bottom of the well was continually on the move; when much water was pumped the sand rose high in the well; when little or no water was pumped it sank again, the fluctuations extending over a depth of more than 100′; the 9″ bore pipe had been broken and twisted (a good deal of it had been removed in cleaning out the well in 1862).

It was then decided to put in a new 12″ bore pipe through the sand, etc., at the bottom of the well to the water-bearing beds below. An incident which occurred while this was in progress showed how the sand moved. The C.R.E., Sheerness, in a letter dated 2. 9. 64 to D.W., states that on August 26th, 1864, while boring was going on for the 12″ pipe, the sand suddenly blew up from the bottom of the shaft, the 12″ bore pipe rose 7′ or 8′ bodily and then sank again immediately to 3′ or 4′ below its former position. A man was killed in this accident, and the boring operations were abandoned.

No. 2 Well.—In 1868–9 it was decided to sink a new brick well alongside the old one to act as an additional reservoir, and to enable two separate sets of pumps to be used, as the set in the old well was constantly injured by sand.

The new, or No. 2, well was carried down to a depth of about 200′, terminating in the London clay. For a depth of 40′ it was made with iron cylinders 6′ in diameter, then the same diameter was carried on in brick to a depth of about 100′, at which point the well was domed out to 9′ diameter, which was carried down to the bottom (see *Plate, Fig.* II.).

Heading between the Wells.—The two wells, 16′ apart, were connected by a heading, brick lined, of egg-shape section, 6′ high by 4′ at the broadest point. In this heading there is a brick partition with an iron door, and under the door a 12″ C.I. pipe with a sluice valve and opening gear worked from the surface, the object of this arrangement being to allow of water passing from No. 1 into

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No. 2 Well, when it rose sufficiently high in the former, while any rush of sand could be excluded.

9″ *Bore Pipe, No. 2 Well.*—Sand continued to give trouble, and got into both the new and the old well, and in 1877 it was decided to put down a 9″ bore pipe from the bottom of the new (No. 2) well into the chalk. The boring came on chalk at 501′, and after the tube had been carried 4′ into it, the bore hole was carried on unlined to a depth of 806′, at which point the boring was stopped, as a good supply of water had been obtained.

Absence of Sand, No. 2 Well.—This bore is clear throughout its depth to this day. It is stated in several reports that no trouble has been caused in No. 2 Well by sand, as the supply of water is obtained from the chalk. This is probably misleading, as the water evidently passes down from the Thanet beds along the outside of the lower portion of the bore tube, or through fissures in the chalk caused by the boring operations, into the bore hole and thence up the inside of the bore tube, and in this way the sand is filtered out of the water.

Dockyard Well.—Analyses of the water, which is soft, also show that it does not come from chalk springs. It is not believed that any water is obtainable from the chalk, in proof of which may be mentioned the case of a well in the dockyard. In the process of boring, water was met with at various depths in the sand beds, but in the hope of obtaining a better supply from the lower greensand supposed to be under the chalk, the bore was carried to 1,500′ below the surface, at which point the water disappeared, probably owing to a fissure in the chalk having been struck. The boring was stopped and the tube blown up with dynamite at 450′, and water drawn from that depth.

From the study of various geological reports the conclusion has been arrived at that the lower greensand has run out, or been reduced to a very thin stratum, under Sheerness, and that it would be in vain to hope to obtain a supply of water by penetrating through the chalk to unknown depths.

False Bottom, No. 1 Well.—To return to No. 1 Well. In order to keep down the sand which was constantly rising, a false bottom of 7′ diameter was fixed, at 160′ down, in 1882, made in four segments of C.I., tongued, grooved, and bolted together, of 9″ thickness at the centre and 6″ at the sides, and built into the walls. A 6″ valve was fitted in one segment, by which water could be admitted into the upper part of the well. The removal of this false bottom in 1906 was a work of considerable difficulty.

No. 2 Well Boring.—When the boring in No. 2 Well was completed, the water stood at a level of 70′ below ground. This level had sunk to 120′ by 1884, and to 137′ in 1887. In 1884 it took 2½ hours to pump 10,000 gallons, and the water was lowered 13′ in the well;

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24,000 gallons could be pumped in 6 hours 40 minutes, lowering the water 22′. In December, 1888, the average daily consumption, 11,000 gallons, was pumped in 3 hours, lowering the water 28′; 20,000 gallons could be pumped in 5 hours, lowering the water 32′.

Steam Pump, No. 2 Well.—In 1887 a single-throw pump 6″ diameter and 3′ stroke, driven by a horizontal high-pressure non-condensing engine of 7-H.P., was fixed in No. 2 Well, and is still in use, but it is hoped that it will be shortly replaced by a modern 3-throw pump. The suction is 197′ below surface, and the pump delivers 4,000 gallons per hour.

The water level in No. 2 Well continued to fall at the rate of about 4′ per annum, and it was frequently necessary to augment the supply from the Dockyard and Town Waterworks.

Proposed Storage Tank.—Early in 1904 proposals were submitted for an additional high level storage tank, in order to maintain a reserve in case of fire or temporary stoppage of the pump, and to facilitate supply to the higher cisterns in the barracks.

Existing Storage.—The existing storage consists of a brick tank of 12,000 gallons capacity on the ground, built in 1829. In 1859 a circular iron tank of 15,000 gallons capacity was built over it, 20′ above ground, and this tank was added to in 1874, bringing its capacity up to 25,000 gallons.

Water Famine, 1904.—During the summer of 1904 there was almost a water famine in Sheppey. The yield from the town, dockyard, and W.D. wells was below the average, great difficulty was experienced in supplying the garrison, and the strictest economy had to be enforced. The water level in No. 2 Well dropped to 185′, or to 15′ from the bottom of the well, which was often pumped dry a dozen times a day. It became evident that the proposed storage tank would be of little use without sufficient water to pump into it, and the question arose as to the best means of increasing the supply.

Decision to clear No. 1 Well.—Various schemes for new wells and improvements to the old ones were carefully considered, and it was finally decided to clear out No. 1 Well, the main advantage which this course promised being the large reservoir which this fine well would afford if it could be put into serviceable condition.

On the other hand, nothing was known of the condition of the well below the false bottom, trouble from sand blows was to be anticipated, and there were no data to show to what extent pumping in No. 1 Well, while the excavation of sand and *débris* was in progress, might lower the level in No. 2 Well.

If it had been found that the water in No. 2 was being diminished by the pumping in No. 1, the scheme must have been abandoned, as the water in No. 1 Well could not have been used while excavating operations were in progress, and no other source of supply could

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be reckoned on even temporarily. However the first few hours' pumping in No. 1 Well showed that there was no corresponding fall in the water level in No. 2, and all cause for anxiety on this point was removed.

Allotment of Funds, 1904–5.—£2,000 had been allotted in 1904–5 for a new storage tank, but in view of the above considerations the service was altered to improvement of water supply, and £4,000 for the years 1904-6 were allotted for the clearing of No. 1 Well and the sinking of a new bore tube at its foot (if the existing bores were found to be useless), a sand filter (to keep down sand at the bottom of the well), provision of new pump and gas engine, a high level 12,000-gallon tank, new quarters for the waterworks attendants, new engine house, etc.

The work of clearing No. 1 Well was entrusted to Mr. Batchelor, a well sinker of great experience. As there was no definite information as to the conditions below the false bottom, it was impracticable to make a lump sum or measurement contract, and the work was done by day labour, the plant being paid for at £17 per week.

This may appear expensive, Mr. Batchelor's bill amounting to £2,300, but the money was well spent, as his well-trained and experienced workmen were able to cope with the difficulties encountered, and the operations were carried out smoothly and without any sort of accident or mishap.

Clearing of No. 1 Well.—Mr. Batchelor commenced work in No. 1 Well on November 27th, 1905, by removing the old pumps, girders, etc., and fixing concrete blocks to support 12″ × 12″ pitch pine baulks, from which a pair of 12″ lift pumps were suspended in the well. The pumps were driven by a 14-H.P. traction engine by means of pinion and spur wheel gearing and countershafting. The crank pin of the second countershaft was connected to a pair of rockers, from which the pump rods were suspended.

The suction pipe was capable of extension by means of slides up to 10′, beyond which another length of rising main had to be fitted.

Workmen were lowered and raised and *débris* pulled up by means of a winch, the steam for which was supplied from the W.D. boilers.

The removal of the false bottom and making good the steining was completed by February 16th, 1906, and the temporary pumps, throwing about 10,000 gallons per hour, were then got to work removing water and sand, until the latter began to clog the pumps, after which the sand was shelled out, until shingle was reached at a depth of 246′.

At various depths girders, chains, remains of staging, and other *débris* were met with and removed.

The shingle was shovelled into buckets and hoisted out, and when layers of sand were encountered, the shell was again brought into use.

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In this way the well was cleared to the offset at 265′, and the brick steining was found in good condition except at the offset, where it is dry set and had given way, allowing clay to slide into the well. If this had not been remedied, the well would soon have been choked with clay and the flow of water altogether checked.

Broken portions of the 12″ pipe inserted in 1864 were found and removed, and the top of the first bore pipe, 9″ in diameter, which had been put down in 1855, was encountered at 263′. Both pipes were found to be choked solid with sand and *débris*, and no water was issuing from them.

In two neighbouring wells of very similar construction, from which the town water supply is drawn, the bore pipes are also filled up in the same manner, and water is only obtained through the floors of the wells outside the bores. Consequently it would appear to be useless to attempt to obtain water from borings into the Thanet beds unless special precautions are adopted to exclude sand, or the water is drawn out very slowly.

At Slough Fort a boring was sunk into the tertiary beds in 1902, but sand caused endless trouble until the speed of the pump was reduced, and since this was done there has been no trouble in obtaining the small supply required.

Old drawings showed a concrete slab at the level 265 which does not exist, but the well below that point is filled with coarse shingle, which must have been thrown in many years ago to keep down the sand, but ineffectually, as a large quantity of sand had passed through it into the upper part of the well.

During the 23 years No. 1 Well was closed down, the shingle may have settled and consolidated, at any rate it now holds the sand in check, and the special sand filter, which it was proposed to fix at the level 265, is not required. It was evidently useless to attempt to clear either of the old bore pipes or to make a fresh boring, as the latter would soon share the fate of the old ones and become clogged with sand.

Mr. Batchelor recommended the enlargement of the well to 9′ diameter to the base of the London clay, but this proposal was vetoed on account of the great expense that would have been involved, and also in view of the trouble that might be anticipated from sand blows when the bottom of the clay was reached.

A series of tests showed that water was coming in at 265 at the rate of 5,000 gallons an hour, and as it was clear and free from sand, it was decided to leave well alone and cease operations in the well; and the temporary pumps and gear were removed by September 1st, 1906.

Standpipe.—Before operations were commenced in No. 1 Well, water used at times to rise through a valve in the false bottom and

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pass through the heading into No. 2 Well. The rest level in the well was therefore assumed to be about 150′ from the surface, and the well being cleared out to 265′, formed a reservoir containing about 34,000 gallons, into the bottom of which water enters at 5,000 gallons per hour, or twice the rate at which it can be pumped out by the new pump, delivering 2,500 gallons per hour.

It was therefore considered unnecessary to provide the proposed 40,000-gallon storage tank mentioned above, but it was still very desirable to produce greater pressure in the mains than could be obtained with the existing 25,000-gallon tank, in order to reach the high level cisterns in the married quarters, and for fire purposes. This was satisfactorily accomplished by erecting a standpipe of 4″ diameter (57′ above ground level and 15′ 6″ above the highest water level in the 25,000-gallon tank), which can be pumped through direct from either well.

The cost of providing and fixing this standpipe amounted to £65 10s. 5d.

New Pump in No. 1 Well.—No. 1 Well then had a rest of six months, from September, 1906, to March, 1907, during which time Messrs. Tangye fixed a 3-throw pump, bore 4½″, stroke 12″ in the well, designed to deliver 2,500 gallons per hour at a speed of 23 revolutions per minute. By means of iron girders fixed across the well and a winch to take the weight, the pump was put together and lowered section by section entirely from the surface. The end of the suction pipe was fixed at 248′ from the surface, and was fitted with a rose, consisting of two perforated cylinders one inside the other, specially designed to exclude sand. Stages were also fixed at depths of 6′, 50′, and 100′ below the surface and connected by vertical iron ladders secured to the walls.

The cost of this pump, including fixing, was £557.

Electric Motors.—By this time funds were nearly exhausted, only about £350 remaining out of the £4,000 allotted, to provide the power for the two pumps and rebuild or repair the engine house, and it was further considered very necessary to replace, by a more modern and efficient type, the pump in No. 2 Well, which was nearly worn out and of a very antiquated cumbersome pattern.

With a view to economy, not only in first cost but also in working expenditure, in maintenance, and in supervision, it was proposed to provide electric motors as the driving power in lieu of the gas engines authorized; the current to be obtained from the Sheerness Electrical Power Company, whose main ran to a point about 200 yards from the pumping station.

The cost of providing and fixing one motor, inclusive of laying the necessary extension of cable, was quoted at £88, with a guarantee to maintain the plant in running order for two years, which—as compared with gas engines—would be a saving in initial cost of about £130 for each well.

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The proposal included the use of automatic starting gear worked by a float in the storage tank which would ensure that the tank was always kept full, and—by the use of a resistance cut out gradually by a solenoid—obviate any danger of the motor being put to its full power too suddenly, so damaging the gearing or pump. Also no labour would be required for starting and stopping the motor.

It was estimated that the cost of working and supervision would not exceed—and might be considerably less—than it would be if gas were used.

The estimates also showed that an annual saving of at least £100 would be effected by providing a new pump in No. 2 Well driven by electricity (or gas), in place of the existing steam pump, which involved the employment of an engine driver and stoker, whereas one attendant would be sufficient to run gas engines or motors, and in the case of the latter, his whole time need not be devoted to the pumping station.

An objection that the extreme damp often experienced at Sheerness might be prejudicial to the efficiency of electrical plant, was answered by a visit to a private pumping station where a motor had been running quite satisfactorily in a very damp engine house for four years without any repairs or renewals.

Any risk of failure of water supply owing to a breakdown of the electrical generating station would equally apply if gas were used, but, in the case of the former, there will shortly be an alternative source of supply, viz., the dockyard, in which extensive electrical works are being installed.

The pump already fixed was fitted with fast and loose pulleys for belt driving, the countershaft to run at 95 revolutions. It was estimated that a motor of 7-B.H.P. to run 500 revolutions, could be arranged to drive the pump direct by means of toothed wheels, the step-down of the gearing being a trifle over 5 to 1.

Contract for Motor.—A contract was accordingly entered into with the Sheerness Electrical Power Company, which provided and fixed a 7-B.H.P. motor, manufactured by the Brush Electrical Engineering Company, type E 12, with float switch, starting switch, and rheostat, for £88 11s. 3d., this sum including the supply and fixing of a cast-iron spur wheel (in place of the pulleys on the countershaft of the pump), which was geared into a raw hide pinion on the motor spindle. There was also a guarantee to maintain the installation in working order for two years.

Speed of Pump.—The speed of the pump was arranged as follows :—

Revolutions of motor per minute	445
Teeth on pinion on motorshaft	19
Teeth on spur wheel on countershaft	85
Teeth on pinion on countershaft	16
Teeth on spur wheel on crankshaft	72

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which gives a theoretical speed of 22·1 revolutions per minute of the pump. Actual trials show that the speed varies between 21 and 23 revolutions per minute.

Test of Motor and New Pump.—The motor was fixed by March 15th, 1907, and after some trial runs, which showed that everything was working satisfactorily, a 24 hours' continuous run was made on March 21st and 22nd, with the result that 2,800 gallons per hour were pumped, the water level having been reduced during that period from 170′ to 208′ below the surface, leaving a depth of 40′ of water above the suction of the pump.

No. 1 Well taken into Use.—The water having been analyzed and reported thoroughly good, No. 1 Well was taken into regular daily use on April 28th, 1907.

Cost of Pumping by Electricity.—The Electrical Power Company offered to supply the current at a flat rate of 2d. per Board of Trade unit, or on a sliding scale of 3½d. per unit for the first 100 hours' running of the quarter, and 1½d. afterwards, and courteously agreed to allow a decision as to which rate should be adopted to stand over until the motor had been in use for a quarter, by which time sufficient experience would be gained to determine which rate would be the more advantageous to the War Department.

The sliding scale was adopted as the more economical, as proved by the following figures. It was found by trial that the consumption of current per hour was 3·8 kilowatts to pump 2,500 gallons, or 1·52 kilowatts per 1,000 gallons.

On the sliding scale the consumption during the first 100 hours' running in the quarter is charged at 3½d. per unit, or at the rate of $1{\cdot}52 \times 3{\cdot}5 = 5{\cdot}32$d. per 1,000 gallons.

The remainder consumed is charged at 1½d. per unit, or at the rate of $1{\cdot}52 \times 1{\cdot}5 = 2{\cdot}28$d. per 1,000 gallons.

The consumption of water per quarter varies between 1,000,000 and 1,500,000 gallons. Taking first 1,000,000 as the amount pumped during the quarter, 1,520 units would be used in pumping. During the first 100 hours 380 units would be used at the higher rate of 3½d. and the remainder at 1½d.

The cost therefore would be :—

	£	s.	d.
380 units at 3½d.	5	10	10
1,140 units at 1½d.	7	2	6
	£12	13	4

At the flat rate of 2d. per unit the cost of the 1,520 units required to pump 1,000,000 gallons works out at £12 13s. 4d. Exactly the same as the sliding scale.

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If 1,500,000 gallons were pumped, the figures would be :—

Sliding Scale.

	£	s.	d.
380 units at 3½d.	5	10	10
1,900 units at 1½d.	11	17	6
	£17	8	4

Flat Scale.

	£	s.	d.
2,280 units at 2d.	19	0	0

or a balance of £1 11s. 8d. per quarter in favour of the sliding scale, which was accordingly accepted on the usual form of agreement.

Comparative Cost of Electricity and Steam.—During the three months in question the steam pump in No. 2 Well was not used at all, and it is possible to compare the cost of pumping by steam in 1906 with the use of electricity in 1907.

May, June, July, 1906, gallons pumped 1,383,000

	£	s.	d.
Pay of engine driver for 3 months	25	7	0
Pay of stoker	23	3	10
Coal (43½ tons at 24s.)	52	4	0
Total	£100	14	10

May, June, July, 1907, gallons pumped 1,456,000

	£	s.	d.
Pay of motor attendant	25	7	0
Electric current (380 units at 3½d.)	5	10	10
Electric current (1,576 units at 1½d.)	9	17	0
Total	£40	14	10

The substitution of electricity for steam therefore causes a saving of at least £240 per annum.

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Comparative Cost of Electricity and Gas.—We have not such exact data for a comparison with the cost of using gas engines, but it is estimated that the gas bill would amount to £58 per annum, as against £62 for electric current; but this small difference should be balanced by smaller annual expenditure on repair and maintenance of motors, and the initial cost of the latter is under £180 (for two motors) against an estimated cost of £450 (for two gas engines). Also the use of automatic starting gear ensures that the storage tank is always kept full, and that pumping would commence directly any water was drawn from the tank, which would be a great advantage in case of fire.

Water Level in No. 2 Well.—No. 1 Well having been satisfactorily brought into use, after being abandoned for 30 years, attention was turned to No. 2 Well, to ascertain to what extent it could be relied upon as a second source of supply.

The water level had fallen 115′ (from 70′ to 185′ below the surface), at the rate of nearly 4′ per annum, and the pump was practically worn out.

As the well had been continuously drawn upon for many years, with an occasional rest only of a few days at a time, it was impossible to determine to what extent the above figures represented the true fall of the general water level of the source of supply. If it had been found that after a rest the water did not rise much above the 185 level, it would not be worth providing any new pump in the well itself, as the latter would be permanently dry in a few years, and in that case it would have been advisable to fix a bore tube pump some 50′ below the bottom of the well.

The latter course would be quite practicable (but it will be seen below that it was not necessary at the time), as it had been ascertained by sounding that the bore tube was clear to its full depth, *vide* paragraph above on "absence of sand in No. 2 Well."

The well (No. 2) was rested from April 25th, 1907, and the water rose steadily, till at the end of six weeks it reached the heading and flowed through into No. 1 Well. It was again pumped out on June 5th and then left at rest. This time the water rose to the heading in 12 days.

These results show that the fall of the water level in previous years was not so much due to a subsidence of the source of supply generally, as to the continual drain on the water-bearing strata round the bore, by which an ever-increasing area was denuded of water, and had to be filled up before there could be any rise in the well.

No. 2 Well.—The contract for clearing No. 2 Well, and for manufacturing and erecting new 3-throw pumps in it, was entrusted to Messrs. Warner & Co., of Walton-on-the-Naze, and their men arrived at Sheerness with the new machinery on the 29th of January, 1908.

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The work of clearing the well of old stages, girders, and baulks of timber used as temporary stages at different times, was first taken in hand, and, as some of these were fixed below the water level, the old pump was used to keep the water down until they had all been removed and holes in the brickwork made good.

The girders, etc., in the upper portion of the well were next taken out, also the old sluice valve fitted in the heading, and "opening rods" to same, which had been fixed to enable the valve to be manipulated from the top of the well.

After this, the old pump—consisting of heavy cast-iron standpipes and air vessel—was removed, leaving the well clear of all obstructions.

To support the new pumps, two massive girders were fixed into the well at a depth of about 142′ from the floor level, the new pumps being suspended from these girders. A strong platform of cast-iron gratings was fixed on these girders, and the new pumps were lowered on to the platform, connected up, and then lowered into position and secured to the girders by bolts.

The pumps consist of a head box, 9′ to 12′ lengths of standpipe (three lengths to each pump barrel), three gun-metal barrels, and one footbox. From the footbox one suction pipe is suspended, having a strainer of special design at its end, being at a depth of 198′ from the floor level. Half stages are also fixed at 4′, 50′, and 100′ from the floor level, and a vertical ladder is led from top to bottom platform, as in No. 1 Well.

These ladders and platforms have proved of great use, as any part of pump rods or rising main can be easily reached for repair or examination. With the old pumps there were no ladders; consequently, if an inspection had to be made or repairs carried out, it required a winch and overhead gear to lower a seat on which the workmen sat. It was also necessary to have two men on the winch, and a third on the first stage to guide the rope to which the seat was attached; now one man can descend either well to any depth, and carry out any small repairs without assistance from the top.

The driving gear on the top consists of a cast-iron box frame, carrying the crank and countershafts in bearings, and also supporting guide barrels for the crossheads. Each crosshead is connected to a crank by a connecting rod, and from the lower side of the crosshead the pump rods are hung.

In the well, at intervals of 12′, the pump rods pass through adjustable oak guides secured to girders, to prevent excessive vibration of the rods.

The caps of crank and plummer block brasses are all made adjustable to take up wear on brasses.

On one end of the crank shaft is keyed a cast-iron spur wheel,

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having 71 teeth, which gears with a raw hide pinion on the countershaft having 15 teeth, and at the other end of the countershaft a cast-iron spur wheel, having 118 teeth, gears with a raw hide pinion with 19 teeth on the motor spindle.

With the motor running at 440 to 450 revolutions per minute, the above train of wheels gives a speed of from 15 to 16 revolutions of the pump per minute and an output of 2,150 gallons per hour.

While Messrs. Warner's men were erecting the pumps, the Sheerness Electric Power and Traction Company fixed the motor and connected it up to their existing main; they also fixed the switchboard with the necessary connections to the automatic switch on the storage tank.

The motor is a duplicate of the one driving pumps in No. 1 Well ("E 12" type), made by the Brush Electrical Engineering Company, of Loughborough.

By 20th March the machinery for No. 2 Well was completed, and since that date No. 2 has been used on Wednesday and Thursday, and No. 1 on Monday, Tuesday, Friday, and Saturday of each week, with a plentiful supply of water at all times.

After two days pumping, the water in No. 2 Well rises and flows through the heading in about 30 hours, and after about 40 hours' rest—that is, from Saturday to Monday—the water in No. 1 Well is usually up to the heading. During the months of June, July, and August, after the heaviest pumping day (Monday), the lowest level reached was 199′ 8″ from floor level, leaving 48′ 4″ to be pumped before drawing air.

As the old pumping-house building was to be pulled down, a temporary shelter was erected over the wells to protect the machinery from dust, rain, etc., while a new pump room was built.

At the same time the old engine driver's quarters, boiler room, engine room, workshop, and store were pulled down, and after the roof was on the new pump room the temporary shelter was taken down, these operations being carried out without stopping pumping for one day.

The new building—37′ long by 18′ wide and 13′ high—is a well-lighted and convenient room, and forms a good workshop, as the benches, vices, and lathe from the old workshop have been erected in it.

	£	s.	d.
The cost of Warner's pumps was	417	0	0
The cost of No. 2 Motor was	99	6	3

including 100 yards of lead, and hand lamps for use in the wells.

The cost of new pump room was £168.

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Three-Throw Pump and Motor for No. 2 Well.—The yield of this well was insufficient when it constituted the whole source of supply, but it should prove valuable in supplementing the yield from No. 1 Well, as it will only be used alternately with the latter and have frequent periods of rest, during which it is anticipated that sufficient water will collect to supply the garrison for a few days at a time, and justify the provision of a 3-throw pump and motor similar to those in use at No. 1 Well.

It is hoped that an adequate supply of water for the Sheerness garrison has now been assured for many years to come.

Contracts.—Two portions of the service were carried out under special contracts, viz. :—

(1). Clearing out old pumps, girders, etc., from No. 1 Well—contractor, Mr. R. D. Batchelor. Total cost, £2,323 2s. 1d.

(2). Building quarters for engine driver and sluice opener—contractors, Frank Miskin, Ltd. Total cost, £564 19s.

The contracts for supplying and fixing new pumps were made by War Office as follows :—

No. 1 Well.—Messrs. Tangyes, Ltd. Total cost, £557.

No. 2 Well.—Messrs. Warner & Co., Ltd. Total cost, £417.

The electric motors for driving the pumps were supplied locally by the Sheerness District Electric Light and Power Co. Total cost, £187 17s. 6d.

The remainder of the work, including erection of new pump room and taking down old buildings, was carried out by the triennial contractor and civil labour. Total cost, £447 18s. 8d.

The total cost of the whole service was £4,497 17s. 3d.

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SHEERNESS WATER SUPPLY.

FIG. I.

DIAGRAM OF NO. 1 WELL.

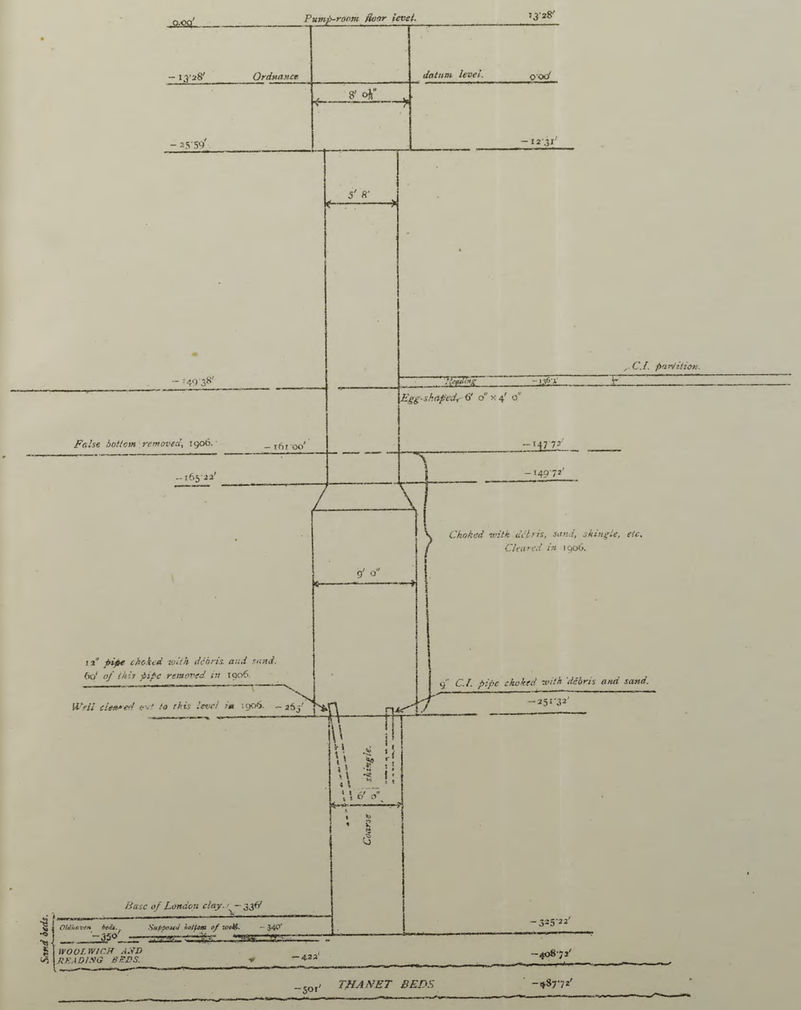

NOTE.—Levels on right have reference to Ordnance datum
Levels on left are below pump-room floor.
0·00′ Pump-room floor level. 13·28′
−13·28′ Ordnance datum level. 0·00
8′ 04″
−25·59′ −12·31′
3′ 8′
C.I. partition.
−149·38′
Egg-shaped, 6′ 0″ × 4′ 0″
False bottom removed, 1906. −161·00′ −147·72′
−165·22′ −149·72′
Choked with débris, sand, shingle, etc. Cleared in 1906.
9′ 0″
12″ pipe choked with débris and sand.
6d of this pipe removed in 1906.
9″ C.I. pipe choked with débris and sand.
Well cleaned out to this level in 1906. −253′ −251·32′
Coarse shingle.
6′ 0″
Base of London clay. −336′
Sand beds.
Oldhaven beds. −350′
Supposed bottom of well. −340′ −325·22′
WOOLWICH AND READING BEDS. −422′ −408·72′
−501′ THANET BEDS −487·72′

FIG. II.

DIAGRAM OF NO. 2 WELL.

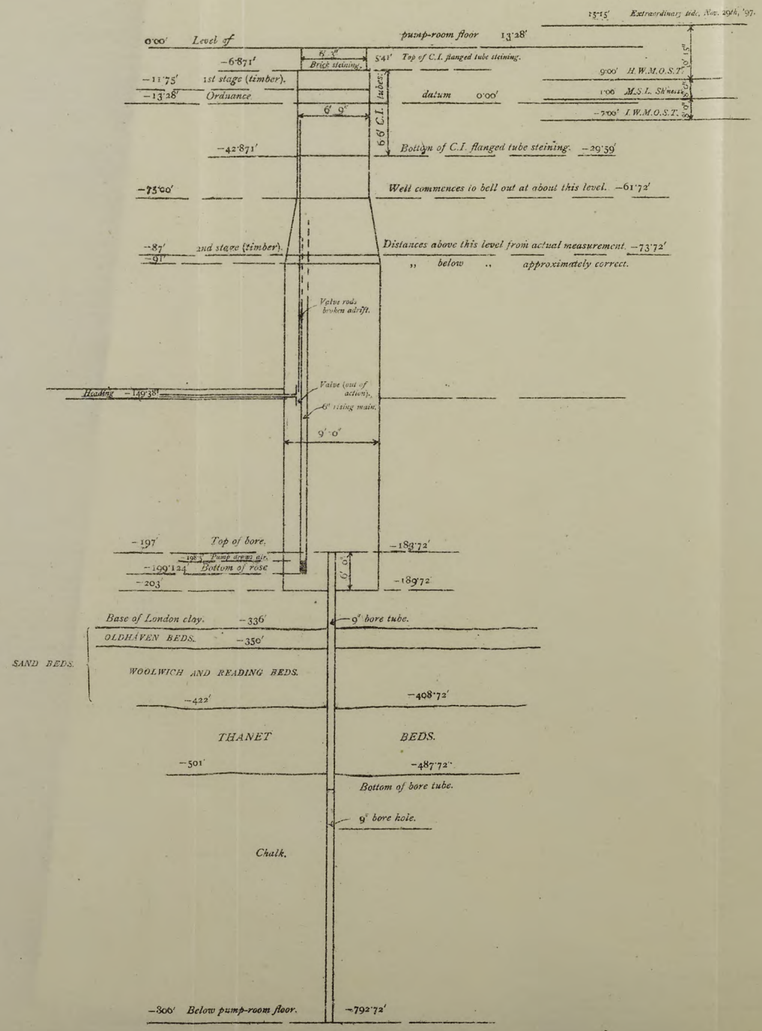
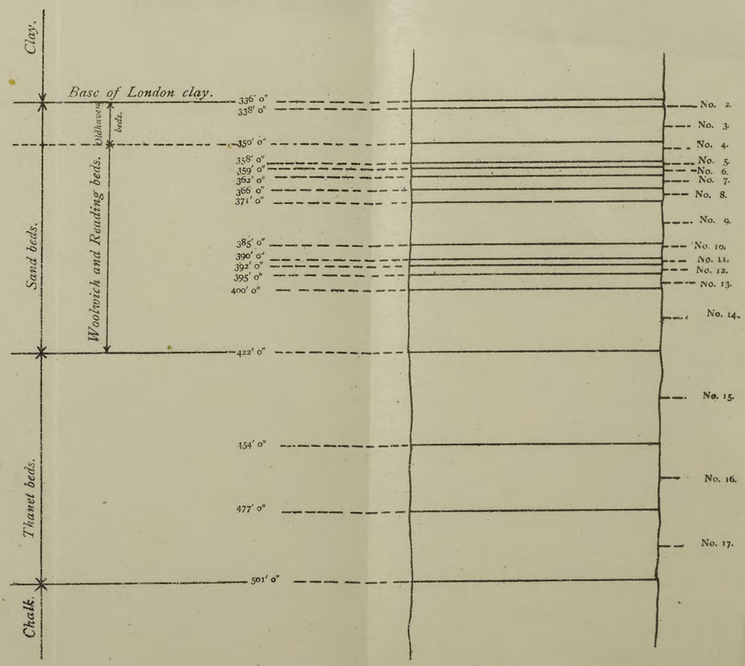

NOTE.—Figures on right have reference to Ordnance datum
Figures on left are below pump-room floor.
15·15′ Extraordinary tide, Nov. 29th, '97.
0·00′ Level of pump-room floor 13·28′
−6·87′ Brick staining. 5·41′ Top of C.I. flanged tube staining.
−11·75′ 1st stage (timber).
−13·28′ Ordnance datum 0·00′
9·00′ H.W.M.O.S.T.
1·06 M.S.L. Sheerness
−7·00′ L.W.M.O.S.T.
6′ 9″
6′ 6″ C.I. tubes
−42·87′ Bottom of C.I. flanged tube steining. −29·59′
−75·00′ Well commences to bell out at about this level. −61·72′
−87′ 2nd stage (timber). Distances above this level from actual measurement. −73·72′
−91′ ,, below ,, approximately correct.
Valve rods broken adrift.
Valve (out of action).
6″ rising main.
Heading −149·38′
9′ 0″
−197′ Top of bore. −183·72′
−199·122 Pump level O.S.
−203 Bottom of rose −189·72
6′ 0″
Base of London clay. −336′
9″ bore tube.
OLDHAVEN BEDS. −350′
SAND BEDS.
WOOLWICH AND READING BEDS.
−422′ −408·72′
THANET BEDS.
−501′ −487·72′
Bottom of bore tube.
9″ bore hole.
Chalk.
−806′ Below pump-room floor. −792·72′

FIG. III.

DIAGRAM OF BORING OF NO. 2 WELL, SHOWING STRATA.



NO.	DESCRIPTION OF STRATA.	DEPTH, FT.
No. 1	Common clay from surface	336
,, 2	Black clay and sand	2
,, 3	Green sand and clay	12
,, 4	Grey sand	8
,, 5	Black sand	1
,, 6	Light clay	3
,, 7	Green sand	4
,, 8	Sand rock	5
,, 9	Green sand	14
,, 10	Grey sand	5
,, 11	Green loamy sand	2
,, 12	Dark grey sand	3
,, 13	Green sand	5
,, 14	Dark black sand	22
,, 15	Dark sand and rotten shells intermixed	32
,, 16	Soft sand rock	23
,, 17	Dark blue sandy clay	24
,, 18	Chalk	305
		806

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MOTOR CARS.

Lecture delivered in R.E. Institute on March 11th, 1909, by

MERVYN O'GORMAN, ESQ., M.INST.E.E., M.INST.MECH.E., M.INST.A.E.

As the subject is a large one I propose to limit myself to petrol cars. Let us consider the source of energy for a motor car, namely, the petrol. All liquid fuels of this type burn with air to produce almost exactly the same amount of energy per pound, viz., 20,000 British thermal units, and the amount of oxygen consumed is almost $3\frac{1}{2}$ lbs. Accordingly, as fuel is bought per gallon, the denser the fuel, the more energy do we get into the tank of a car. This heavier fuel is also cheaper; so that, provided equally complete combustion is obtained, there is every inducement to the user to employ the densest fuel that he can burn without producing soot or smoke, or getting more than 2 per cent. of CO from his exhaust.

Now a horse-power hour is equivalent to 2,544 British thermal units, say 2,500.

Therefore 1 lb. of petrol should work a 25-H.P. engine for	0·32 hrs.
But the efficiency of the engine is only 25 per cent., thereby reducing the time for which the 25-H.P. is available to	0·08 hrs.
There is now the energy wasted in the car itself, which has only about 80 per cent. efficiency; so that 1 lb. of fuel will give us 25-H.P. at the road wheels for a period of only	0·064 hrs.
But 25-H.P. will propel a car at the rate of 40 miles per hour. Therefore the distance to be got (on Brooklands say) from 1 lb. of petrol is 2·56 miles per lb., that is 20·5 miles per gallon.	

In this paper I shall take the liberty of assuming that everyone, although familiar in a general way with the use of motor cars, has not, for one reason or another, made any detailed study of the subject. There is an engine, a clutch, and a gear box, which, if the back of the car be jacked up, cause the axle and its wheels to rotate. If the tires happen to be in contact with the ground, they push the ground backwards and the car forwards through one or a pair of push rods or radius rods. In cheapening things for the purposes of manufacture the forward parts of the back springs are sometimes used as push rods.

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Effort of the Back Wheels.—It will be noticed that the back wheels begin their effort at that portion of their circumference which approaches the ground, and there is a reaction equal and opposite to this effort tending to raise the bonnet end of the car upwards. This effort is transmitted through the torque rod. If we suppose for a moment that a giant is holding the car in the air when its first speed gear is engaged, and is lifting it by its two back wheels only, so that the bonnet hangs vertically downwards, it will be seen that when the clutch is let in, the effort of the engine will slowly raise up the front of the car out of the perpendicular, and if the engine be powerful relatively to the weight of the chassis, it might eventually cause the car to rotate bodily, so as to bring the engine over the back seats. We need not prosecute this consideration any further; it simply shows to us that the torque rod which is fixed to the back-axle tube is tending to lift the bonnet end off the ground when the engine works, a consideration which was sometimes disregarded in the early designs.

When the car is in its lowest gear, the torque of the engine is multiplied by the greatest multiplying factor, which may, for a 4-cylinder "4-inch" car, 25 by R.A.C. rating, be as much as 8·75 to 1. And so it happened that formerly when a single-cylinder "4-inch" engine was put in the back of the car, and when the gear box, the carriage body, and the driver were all so situated that their united centre of gravity was not very far in advance of the back axle, it became possible for a car which was being put to climb up a steep hill to place the driver in a position which, though disadvantageous as regards comfort, helped him to appreciate the magnitude and direction of the forces acting through the torque rod.

To come to figures. One cylinder of a modern "4-inch" car can exert an effort of 1,000 lbs. on its crank. If the lowest gear were in use, the tendency to turn the car over would be measured by a tangential pull of 164 lbs.,* exerted at the front axle, which we will say is 10′ from the back one. If the back wheels were held up by the giant, this would appreciably tilt a modern car weighing 3,000 lbs.; but with an old car of 5′ wheel base, with a higher gear reduction, and weighing 1,000 lbs., the backward somersault was always a possibility.

* Explosion mean pressure = 80 lbs. per square inch.
Number of square inches in a 25·6 R.A.C. rated engine cylinder = say 12·6 square inches.
Total pressure = say 1,005 lbs.
Length of leverage of crank, 2·25″.
Multiplication by gear = 8·75.
Total torque = 1,000 × 8·75 lbs. at 2¼″.
Upward pressure at 10′ distance = 164 lbs.
Pressure at end of torque rod 5′ long = 328 lbs.

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Were it not for the elasticity of the parts and the inertia of both the flywheel and the car as a whole, the effort would be transmitted in full through the torque rod, which, being about half the wheel base in length, or say 5′ long, might on the modern car transmit an upward pressure of about 328 lbs. on to the cross stay of the chassis frame to which it is fixed. In practice it will be found possible to make a car bounce considerably on its springs by simply clutching and unclutching rhythmically. The longer the wheel base, and the more the engine weight is kept forward, the less will this bouncing movement be felt.

This is one of the many causes that conduce to the "smoothness" of a car having a long wheel base. This must not be confused with the smoothness due to the smaller explosion reaction in a 6-cylinder car, to which as a rule is superadded the advantage of a long wheel base.

The Application of Brakes.—When the brakes are acting the opposite effect is produced, and the front end of the car is pressed strongly downwards on to the ground. This has an undesirable effect for cars having brakes on the back wheels alone, because whatever *steady* pressure is added to the front wheels is taken off the back ones, for the obvious reason that the total steady pressure on the ground cannot exceed the total weight of the car. The result of applying the brakes is therefore slightly to diminish the adhesion of the very wheels on which the driver depends for a good grip of the road. Braking on the front wheels will better illustrate this tipping effect on the car. This transfer of weight from the back wheels by braking is one reason why a better retardation may be obtained if the brakes are not applied so forcibly as to skid the back wheels. The other and chief reason is that once the wheels skid they make for themselves roller bearings out of the loose gravel, sand or stones, which may have been detached by the scraping action of the skid.

To Avoid Skidding.—From this consideration we learn the reason for a curious practical device in driving of which very few people know, called "chattering" the brake. As it is almost impossible to know the precise degree of pressure required for the best operation of the brakes, some drivers have learnt to avoid skidding and yet to get the desired retardation by "chattering," that is putting the brake quickly on and off by a rapid, but small, up-and-down motion of the foot. This tip for avoiding side-slip was given to me without explanation by Mr. Northey, of the Rolls Royce Company, and I have used it for a couple of years with undoubted advantage. The ideal arrangement is however to have brakes on all four wheels, and so use the whole adhesion of the car for stopping.

When I said that the total steady pressure on the ground cannot exceed the total weight of the car I was alluding strictly to the *steady* pressure (not to what, as an electrical engineer, I may call the "root-

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mean-square-pressure"). I do not imply that the car cannot exert by reason of its motion up and down a pressure on the ground greater than its weight on the weighbridge. On the contrary, one regrets that this cannot truthfully be said, because it would be so much kinder to the tires and to him who pays for them. Momentaneous rises of pressure on the tires, to greater values than the car's weight, arise whenever the downward oscillation of the chassis is arrested by the action of the springs and the ground. This, of course, may occur two or three times a second in driving, and on a car 25 by R.A.C. rating it may amount to 700 or 800 lbs. (as indicated by the flexure of the springs), and so the walls of the tires are bent and unbent. This movement is additional to the bending with rolling, and adds its quota to the internal chafing which results in wear, heat, and eventual bursting. The lighter the car the less both effects. Good springing, by making the bending less abrupt, probably adds to the life of tires in some measure.

Weight.—I have rambled on to the question of weight. No one ever knows the separate weights of his chassis, carriage work, and accessories, or the distribution of weight on his car. Yet it is most valuable information. For example, the distance in which a car can be stopped depends almost entirely on weight distribution and not on the total weight.

If 0·6 of the weight is on the back wheels, the rate of stopping or retardation on dry level macadam may be as high as 9′ per sec. per sec. On travelling up a good hill more than 0·6 of the weight is thrown on the back wheels, and the retardation helped by the pull of gravity may go up to 10 or 11′ per sec. per sec. I give a table of stopping distances and times on a one in 15 hill up and a one in 50 hill both up and down. In the case of up-hills the total weight comes in, because a component of the pull of gravity is acting in addition to the adhesion. Mr. New has given a useful mnemonic for the distance of stopping in feet, which, if the speed is V miles per hour is $\frac{V^2}{8}$.

Acceleration.—Another matter in which weight is vital is in acceleration. The most pleasurable car to drive is one that accelerates well. It is a car with which it is easy to be virtuous. With such a car there is far less reluctance to slow down for corners, traffic, and villages, because one can so quickly get into one's stride again, and so keep both a good average pace and a clean license. I have suggested the name "liveliness" for the ratio of the number of horse-power available at the road wheels to the weight of a car in hundredweights. I used to think I drove a lively car myself since I took pains to reduce the weight and so to get a liveliness of "unity," that is to say, the car empty weighs 25 cwts. and the horse-power at the road wheels is 25. I calculated that the maximum rate of acceleration of a car (neglecting the transfer of weight) can actually

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attain on dry level macadam to 12′ per sec. per sec.* but in fact nothing so great as this is got in practice save at the moment of starting.

I have found that my car (25 by R.A.C. rating), though it is thought it pulls very well indeed as cars go, gives me an average acceleration of:—

2·2′	per sec.	per sec.	between	10	m.p.h.	and	20	m.p.h.	on 2nd gear.
1·9′	„	„	„	„	„	„	„	„	3rd gear.
1·4′	„	„	„	„	„	„	„	„	4th gear.

These figures were obtained somewhat crudely by observing the speedometer and measuring with a stop watch the number of seconds between the readings 10 and 20; but they are sufficiently close to show that there is a vast difference between the maximum acceleration as limited by adhesion and the maximum as limited by other considerations. I find that the horse-power at the road wheels when worked out on the basis of my acceleration of 2·2 is only 12-H.P. after making allowance for rolling resistance and gear inefficiency. As the engine can give 33-H.P. on the brake at 1,300 r.p.m., it is necessary to see where all this remaining power goes to.

Flywheel.—The balance of the 25-H.P. which the engine is capable of giving is absorbed in accelerating the flywheel and other rotating parts.† The large amount of power (about 4·13-H.P.) required to accelerate the flywheel is worth noticing, because it may prevent erroneous deductions being made as to the horse-power of a motor-car engine from measurements made on acceleration only.

One of the practical deductions from all this, which I am bound to confess was new to me when the experiments were made, is that the

* Total weight = 25 × 112 lbs. = 2,800 lbs.; total mass = 87·5; weight on back wheels = 0·6 of the above weight = 1,680 lbs. Co-efficient of adhesion = 0·625. Total adhesion = 0·625 × 1680.

Maximum force possible = total adhesion = 1,050 lbs. pull.

Force = mass × acceleration.

Therefore acceleration $= \frac{F}{M} = \frac{1050}{87·5} = 12·1'$ per sec. per sec.

† *H.P. expended on Accelerating Flywheel.*—

8″ = time taken to accelerate.

150 lbs. weight of flywheel.

9″ radius of gyration.

4·7′ linear path of centre of mass per rev.

Force = mass × acceleration.

$$\text{Force} = \frac{4·7 \times 50·8}{8} = 29·8 \text{ lbs. pull.}$$

$$\text{Horse-power} = \frac{\text{foot-pounds per min.}}{33{,}000}$$

$$\text{Horse-power} = \frac{4575 \times 29·8}{33{,}000} = 4·13\text{-H.P.}$$

650 r.p.m. at 10 m.p.h. = linear velocity of 3,050′ per min. = 50·8′ per sec.
1,300 r.p.m. at 20 m.p.h. = linear velocity of 6,100′ per min. = 101·6′ per sec.
1,075 r.p.m. at 15 m.p.h. = linear velocity of 4,575′ per min. = 76·25′ per sec.

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wear of tires is not chiefly caused by accelerating, however violently, with even a car that gives 25-H.P. on the brake. The flywheel saves the tires; and it is only the man who races his engine before letting the clutch in who gets sufficiently rapid rate of working on his tires to wear them by skidding. You can get a rate of working at the road wheels far in excess of 25-H.P. by employing the energy of the flywheel, and it is here that the flywheel wears the tires. Accelerating before letting in the clutch is a very common fault, especially with owners of old cars whose engines are not flexible, and accordingly the difference in tire wear between an old-fashioned and a new type of car is noticeable. Any engine that stops as soon as its speed is lessened 30 per cent. naturally teaches its owner that the car must be started off on the energy stored in the flywheel—and just as it is almost impossible to apply a brake with precisely the force which will not skid the wheels, so it is equally difficult to let in the clutch sufficiently gently. The moral on the whole is avoid secondhand cars older than 1908, unless you are skilled enough to apply a new carburettor and to increase the gas passages and valves so as to get a good pull at slow speeds. This brings me to an additional reason why the rate of acceleration is low with many cars, namely, the slow response of most carburettors. As a rule the carburettor takes for each engine speed a certain time to settle down to its proper quality of gas for that speed.

I shall leave the flywheel question now with only the remark that an elementary calculation shows that the flow of energy into a 150-lb. flywheel is at the rate of 5-H.P. for a speed variation of 5 per cent. on the 25-H.P. car I have been considering.

Number of Cylinders.—From considering flywheel effects we are naturally led to a kindred question—what are the merits and demerits of multiplying the number of cylinders?

With one cylinder the impelling force is necessarily supplied in jerks separated from one another by three idle intervals. A large flywheel is needed to prevent the whole car from feeling the interruption in the effort. This is generally supplied, and protection is got for the tires in this way, but it must not be supposed that the engine reaction can be got rid of; on the contrary, it may even be accentuated by an excessive flywheel.

With 2-cylinder vertical engines—which are nothing like twice as "smooth" as 1-cylinder engines—we are placed on the horns of a dilemma. Either the crank is so made for purposes of balance that one piston is up when the other is down, when we get the explosions irregularly spaced (that is two exploding intervals followed by two idle intervals)—or we get the cranks so made that both pistons are up and both down together, in which case the explosions—and therefore the reactions—are quite evenly spaced in time; but the car suffers from the vibration caused by the pistons not balancing one another in any way. The only plan for getting the advantage of

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both systems with two cylinders is the "opposed" engine, where the cylinders are horizontal and face one another. The system works wonderfully well and is quite sound, but fashion has temporarily chased it off the market.

Fashion has similarly been unkind to 3-cylinder engines. If the vertical arrangement of cylinders alone be considered, the 3-cylinders should excel the 2-cylinders far more than these latter do the 1-cylinder class. Four vertical cylinders allow of evenly spacing the explosions and give a very fair degree of balance, but for slow running at no-load a very good carburettor indeed is wanted to secure the quietude which people have been led to demand since the spread of 6-cylinder designs. This exceeding quiet when the car is standing is a luxury which must be paid for either by carburettor excellence or by using more cylinders; the former is the cheaper plan, but the good curburettor is hard to find.

Six cylinders have the one great merit of developing a given degree of power with explosions of only two-thirds the size produced by four cylinders; accordingly the reaction of the engine is diminished. Add to this the fact that the smaller explosions are one-third more frequent, and we get two effects operating to secure that the engine reaction shall approximate to a steady continuous force. I do not think that the saving of tires by using six cylinders is at all important except with engines of large power—over 40-H.P. by R.A.C. rating.

Stopping Distances in feet. Up 1/15 hill.	Speed. Miles per hour.	Time taken in 1/10 secs. for a retardation of 11′ per sec.	Stopping Distances in feet.		Speed in m.p.h.
			Up 1/50 hill.	Down 1/50 hill.	
·25	1	1	·25	·25	1
·5	2	2	·5	·5	2
·75	3	2·5	·75	·75	3
1·25	4	3·75	1·25	1·25	4
2	5	5	2	2·15	5
2·9	6	6·5	3	3·5	6
3·5	7	7·5	4	5	7
4·75	8	9	5·5	6	8
6	9	10·5	7	7·5	9
7·5	10	11·5	8·5	9·5	10
9	11	13	10	11	11
10·5	12	13	12	13·5	12
12·5	13	15	14	16	13
15	14	16·5	16·5	18·5	14
16·75	15	17·5	19	21·5	15
19	16	19·0	22	24·5	16
21·5	17	20·0	24·5	27·5	17
24	18	21	26·5	30·5	18
27·5	19	22·5	30·5	34	19
30	20	23·2	34	38	20

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Stopping Distances in feet. Up 1/15 hill.	Speed. Miles per hour.	Time taken in 1/10 secs. for a retardation of 11′ per sec.	Stopping Distances in feet.		Speed in m.p.h.
			Up 1/50 hill.	Down 1/50 hill.	
34	21	24·8	38	41·5	21
37	22	25·8	41	46	22
40	23	27	45	50	23
44	24	28·2	49	54	24
48	25	29·5	53	58	25
51	26	30·5	57	63	26
55	27	31·6	61	67·5	27
59	28	32·8	66	73	28
64	29	34·2	70	78	29
68	30	35·2	75	84	30
73	31	36·4	80	90	31
78	32	37·5	86	96	32
83	33	38·8	92	102	33
88	34	40·0	97	108	34
93	35	41·1	104	115	35

NOTE.—$S = \frac{1}{2}$ ft². $V^2 = 2$ fs.

PURCHASER OF SMALL CAR.

1. Capital cost, say £250.

2. Annual cost, say 3d. per mile for 5,000 miles = £62 10s. per annum.

First look up official trial results and disregard all other trials and statements, especially statements by wealthy men, who have it from their coachmen who have been told so with inducements from the maker.

Then make a list of possible cars at the possible price that have performed well, and merge all fads, viz., prejudice against horizontal engines, or against accumulator ignition, or chain drive, or method of springs, etc.

Then write for catalogues of the more promising to see what the price includes, noting if the apparent cheapness is due to very small tires and no sundries being included.

Then look at the transmission: clutch, gear box, ignition, back axle, brakes, and their adjustment, as these are far more likely to be defective than the engine.

Then, as high cost of running is what you do not want, and liveliness is what you *do*, consider weight in relation to power.

To get an idea of power try R.A.C. rating. $\left(\text{H.P.} = \frac{D^2 N}{2{\cdot}5}\right.$ where D = diameter of cylinders in inches and N = number of cylinders$\left.\right)$.

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THE TRAINING OF TERRITORIAL FIELD COMPANIES, ROYAL ENGINEERS.

By Capt. F. W. Brunner, R.E.

The guiding principle of a National Army is that the individuals of which it is composed should be allotted, for purposes of war, to the tasks for which their civil pursuits best fit them. No man therefore should be enlisted into the Territorial Royal Engineers who would require to be taught the technical portion of his duties after enlistment.

If high qualifications are insisted upon recruits may come in slowly at first, but in all probability, when it is realized that the Corps is not easy to enter, good men will come forward, and the commanding officer will be able to pick and choose.

If the company is carefully recruited from intelligent artizans—the actual proportion of the various trades hardly seems a matter of great importance, provided that the useful ones, carpenters, smiths, bricklayers, etc., are well represented, and the men are of good physique—its *personnel* would have little to learn as Sappers, from an engineering point of view, beyond the application of their technical skill in the particular directions required for war. Most of this knowledge could be imparted by lectures in the winter evenings, illustrated by diagrams and models, and supplemented by a study of textbooks at home.

The equipment in use could be taught in the same way. For all practical purposes it differs, from similar appliances used in civil life, only in its adaptability to varying circumstances and to the necessity for mobility.

In fact, in order to take the greatest advantage of the limited time available for practical training, nothing should be left to be done out of doors which can equally well be done in the drill hall or at home. For instance, in the case of pontooning, intelligent men can see how the various parts of the equipment fit together on the barrack square, and can learn the duties of the various numbers from a book or in a lecture. They will then be in a position to form bridge in quick time, with very little further instruction when they get to the water.

There is no mystery about warlike engineering operations. A military bridge is only a bridge, which has to be constructed more or less hastily, to pass soldiers over some obstacle. The details of its

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construction consist merely of ordinary artificers' work. The processes of putting a village or farm enclosure in a state of defence, are very simple tasks in their engineering details.

In all these operations, what is required beyond the technical skill, which the civil artificer possesses, is the tactical knowledge necessary to apply it, to execute orders intelligently, to anticipate them, thereby saving precious time, or to act without them on emergency.

The first thing a Sapper has to understand is that the object of his work is to enable the infantry to win the battle. It is as untrue to say that a skilled artificer is a made Sapper as to say that a Bisley marksman is a made infantry soldier. Both have learnt the elements of their trade, but both have still to learn to apply their knowledge to particular conditions.

The application of this knowledge calls for a high state of efficiency in officers and non-commissioned officers, but it would be wrong to argue that it is sufficient for them to have the knowledge The word "anticipate" is the keynote, and it applies not only to the commanding officer, but, in a greater or less degree, to all his subordinates.

The knowledge must be instinctive if it is to be relied on in the stress of battle, and it is hardly too much to say that not a moment will be wasted if the whole of the limited amount of time available for field training be devoted to its acquisition, with the exception of that necessary for elementary military training and musketry.

But, it may be asked, where is the necessity for the Royal Engineers to have all this tactical knowledge? Are there not a General and Staff whose duty it is to issue orders to everyone?

The reply is that it is impossible to foresee and provide for everything in orders. All the General and his Staff can do is to give the correct impulse to his troops, to arrange preliminaries, and to assign objectives. After this has been done, it is the duty of the subordinates—in a greater or less degree according to their seniority—to exercise their initiative in order to meet and take advantage of the varying incidents of the fight.

Admitting, then, the necessity for tactical knowledge, the next point to consider is how it is to be acquired.

We sometimes read, in the accounts of a campaign or battle, that works were constructed with much labour and were never occupied. When we do read this, it is not difficult to imagine the engineers constructing elaborate earthworks during the period before the war in some out-of-the-way field, while the rest of the army was engaged at manœuvres elsewhere. They may have devoted the utmost zeal in the design of their works to ensure protection and to provide for invisibility and fire effect, but all their labour will be worse than useless if the tactical use of the works has not been studied.

Mutual co-operation is the secret of success in war. Hence, the best way to study tactics practically is to take part in combined operations,

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since it is only in these that the working of each arm of the Service can be watched in relation to the others.

Before considering what is to be learnt from these operations, it is necessary to have a clear idea as to what constitute the battlefield duties of the Royal Engineers.

In the defence—and this of course applies to the defensive portions of a battlefield where the general action is offensive—their duties are, speaking generally, to co-ordinate the defensive measures taken by the other troops. While the artillery and infantry provide their own cover, it is the duty of the engineers, assisted probably by working parties from the reserves, to strengthen *points d'appui*, to arrange communications, to carry out or prepare for any necessary demolitions, and generally to execute any work which requires special technical skill, or which does not obviously fall to the share of a unit allotted to a particular portion of the front.

The greater portion of this work can be provided for in orders, and tactical knowledge on the part of the engineers, although very important, is not so vital as it is if they are to do their share in the offensive portion of the field.

Here, after they have been detailed with the troops told off to make an attack and have heard the general instructions communicated, they may receive no further orders until some decisive stage of the action has been reached.

Their efforts in the attack would be directed towards :—

(i.). Strengthening tactical points as the fight progresses, which would be of use in case of a check or reverse.

(ii.). Clearing away obstacles, if required, before a position is assaulted.

(iii.). Taking part in the strengthening of a position gained against a counter-attack in force.

It is in (i.) that tactical knowledge comes most into play.

The business of the infantry soldier is to keep steadily pressing forward, his eyes fixed on the objective and with no thought but to reach it.

The Sapper's duty is to aid him by selecting and artificially strengthening localities in rear of the line as it advances, which will act as supporting points in case it is driven back. If a counter-attack is temporarily successful, a few loopholes knocked in the walls of a farmhouse enclosure and a few obstacles skilfully placed may be of incalculable advantage.

Places strengthened like this will form rallying points, into which the supports and parties of the firing line falling back will gather. They will stand out, to use a metaphor, like rocks in the sea as the tide sweeps on. Some of them will be engulfed, others will remain until the tide recedes again. All will aid in sapping the force of the

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counter-attack by attracting bodies of the enemy by their fire, and those that hold out will materially assist in regaining the ground that has been lost.

To use another simile, the engineers should act like the half-backs of a football team, stopping dangerous rushes and backing up the forwards as they press on again.

In the above work the infantry will take part to a greater or less extent, and this is where the vital importance of combined operations comes into play. The engineers must learn that the infantry cannot be unnecessarily employed on works without the energy required for vigorous offensive action becoming exhausted; the infantry must know that there are limits to the amount of work a small engineer unit can do unaided.

The only way in which this mutual understanding of one another's duties can be obtained is by working together and constantly interchanging ideas. It matters very little in peace manœuvres if there is overlapping, but in war it means waste of energy, and this may involve the loss of a battle.

We are now in a position to consider how combined operations can be used to the best effect as a means of education.

It was pointed out above that it is in offensive action that tactical knowledge finds the most scope. It will therefore be most useful for our purpose to consider the action of the engineers in the attack.

Let us suppose that the field company is attached to a brigade, to which has been assigned a certain portion of the enemy's front as an objective. The O.C. Company will attend, with other commanding officers, to receive the General's orders and to hear any explanations he may give as to the manner in which he proposes to carry out his intention. The G.O.C.'s instructions may or may not indicate some special task for the engineers. In all probability they will not, since the incidents of the fight cannot be foreseen. We will therefore consider the latter case.

When the troops advance to the attack, the engineers should follow up the firing line, moving probably with the supports, and study the ground from the point of view of its capabilities for defence.

As the line moves forward, many accidents of the ground will present themselves, which could be made strong for defence with the expenditure of a little time. But it would obviously be waste of time to strengthen a locality simply because it lends itself to the purpose.

Whenever such a place is noted, then the C.O. should say to himself, "If we were to do some work there, what would be the effect on the operation?" If the reply is none the place is evidently of no value and should be left alone. If any junior officer or N.C.O. asks why it is neglected and is told the reason, he will already have learnt something useful. Sooner or later however some locality will present

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itself, say a farm enclosure or group of buildings, the defence of which might be of great value if the enemy were to make a sudden effort.

There are many points which must be decided mentally before the question whether the place should be defended or not is answered in the affirmative, *e.g.*, is the ground to the front favourable for all arms of the enemy to co-operate in the counter-attack ? Is the place screened from the enemy's probable artillery positions ? Is the configuration of the ground such that his guns could continue firing until the infantry got within assaulting distance, or would they have to cease while it is still at a distance ? And so forth.

If the weighing of these *pros* and *cons* resulted in a balance of advantage in favour of the defensibility of the place, the question should be decided in the affirmative.

The next point to decide is whether it is necessary to employ the whole of the unit, or only one or two sections. The unit, or selected portion of it, should then proceed to the place as soon as the firing line has advanced sufficiently far to allow of its getting there.

While this movement is taking place, a report should be sent to the G.O.C. saying what is being done. It is very important that this should not be neglected, not only in order that the whereabouts of the company may be known in case it is wanted, but also that its action may be discussed at the Conference. It is only in this way that the other arms will learn what the engineers have been doing during the day, and hence will understand what their duties are and what assistance they may expect from them.

The difficulty of bringing home to troops the importance of co-operation is that the result of its failure does not become apparent during peace operations. For instance, if in actual warfare infantry find that they cannot get on, they instinctively turn to the guns for help in overcoming the opposition. In peace operations they do not feel the want, as they are not suffering from the enemy's fire, and individual soldiers may go through a whole day's fight without enquiring what their own artillery is shooting at.

Similarly infantry, when forced to fall back, does not feel the want of artificial cover, because there are no bullets flying about. It is only in similar circumstances, in action, that the leaders begin to say to themselves, "If only we had some strong point to rally the men to, we might hold on until reinforcements come up and enable us to push on again." Then the importance of having these points prepared becomes apparent ; not so much possibly on account of the intrinsic value of the fortifications, as the fact that they afford something tangible to hold on to, and that there is probably a nucleus of men already in occupation.

Having arrived on the spot, the situation should be explained to the men and the unit distributed, tools being laid out and all prepara-

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tions made for starting work. Each N.C.O. in charge of a party of men should satisfy himself that each man knows exactly what he has to do, and officers should move about, correct mistakes, and ask questions, etc.

The O.C., having seen what work has to be done, may consider that there is too much for his unit to carry out without assistance. In this case he should send a further report to the G.O.C., who would decide whether the work is of sufficient importance to render it necessary to detail, from the reserve, a working party to help.

It may not be possible to carry out all the stages above described, since at a field day the attack is generally carried through with more rapidity than it is in real warfare. The O.C. must watch the progress of the fight, and, when he sees that a more advanced position has been won which would have to be retaken by the enemy before the one on which he is engaged could come into play, he should collect his unit and push it forward to repeat the process in another place. Or, before this new position has been carried, the Sappers may be required for the duties under (ii.).

Finally, the unit must be at hand to take part in the strengthening of the ground when a decisive phase of the action has been reached. This will be when a position has been gained where the troops must pause for a time, either because they are exhausted or because ammunition and supplies are deficient.

The operations discussed above do not exhaust the list of those upon which Sappers can be usefully employed during peace manœuvres. In fighting among woods, and in enclosed country generally, sign-posts are required to prevent reserves, supports, etc., losing their way. Then there are minor bridging operations and the destruction of bridges.

The latter must always be a "paper" operation. The points to remember are that everyone concerned in the work should know and be able to explain what has to be done, and that the necessary tools should be at hand and the required time have elapsed before the bridge can be assumed to have been destroyed.

The restoration of bridges is also unfortunately a "paper" operation in most cases. The same rules should be followed, and if there is bridging equipment available, a temporary bridge should be thrown alongside the one supposed to be destroyed.

The golden rule to follow in all peace operations is that it is a great deal better to do too much than to do too little. If someone else's preserves are invaded he will probably complain, and the point will be decided once and for all by higher authority.

It is sometimes argued that manœuvres are of little use to engineers because they cannot actually do any work; bridges cannot be destroyed, walls cannot be loopholed, and so on. There is of course something in this argument, but it must be remembered

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infantry do not use ball ammunition, and yet umpires can estimate the effect of an infantry attack. There seems therefore no reason why the effect of defensive measures, taken or neglected, should not be estimated when considering the result of a counter-attack.

So much for combined operations.

When the unit is acting by itself, the imagination must be called into play, and the fact borne in mind that all military operations, except the most elementary, are meaningless unless they are considered in relation to the action of other arms of the Service besides that engaged.

In such circumstances, instead of men being able to see for themselves what the other arms and the enemy are doing, the O.C. must describe what is supposed to be going on. A defence scheme can next be gone into in greater detail. Or some other military engineering operation can be worked out, *e.g.*, the site for a bridge can be selected and the type of bridge, to be constructed, chosen. Then sketches can be made, parties told off to select and make lists of timber, and others sent to the nearest villages to collect details of tools and materials available.

It is not necessary for the whole unit to be present at these exercises. A few officers and N.C.O.'s are quite sufficient; and if officers of other branches of the Service can attend, so much the better. In fact much can be learned by two or three officers of different arms from each other during the course of an afternoon's walk. For instance, let them suppose an attack to be in progress over the country through which they are walking against an imaginary enemy in position. The infantry officer will describe what his men are doing and the positions that have been reached.

The Sapper may then say, "In that case I shall get to work there." The infantry soldier may reply that this would be useless, since, if the troops were driven back, they would be forced to retire in another direction. The gunner might then point out that the place is a dangerous salient, with reference to the probable position of the enemy's guns, and would be untenable, and so on.

In this way discussions will arise which may be of great value to each, although none of the three has much knowledge or experience. The proverb about the "blind leading the blind" is a hindrance to education if taken to be literally true. Three blind men will get on better together than one will by himself, if each of them knows *something* of the road.

In the preceding pages, only the battlefield duties of Royal Engineers have been considered. Their other duties—in connection with camps, improvement and upkeep of communications, and so forth—are of relatively less importance. They are moreover more akin, both in principle and detail, to work with which a large proportion of the *personnel* will no doubt be familiar in civil life.

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Another point to be remembered in connection with this class of work is that a great deal, which is carried out by the regular Sapper, may be left to units of the Territorial Force to do for themselves, since there will be a large number of men in the ranks with a knowledge of trades.

Speaking of the Territorial Force generally, it seems to the writer that the time officially available for training is necessarily so limited that every opportunity should be seized to supplement it. The Force must become part of the National life if it is to be a success, *e.g.*, it should be impossible for a sergeant in the Territorial Force to find himself junior to a private in his corps in the workshop.

As regards officers, the formation of officers' clubs at each divisional headquarters would do a great deal to foster the acquisition of military knowledge by stimulating the informal discussion of military subjects between officers of different arms. Why should not some of our rich men, who are not in a position to take commissions themselves, come forward and supply the wherewithal to start these ?

The Territorial Force is a new institution with its traditions to make. The Regular Army has suffered much in the past from the idea that it is not good form to "talk shop" when officers meet for social intercourse. It is to be hoped that the officers of the Territorial Force will not fall into the same error.

Finally, there is a great *rôle** for the Royal Engineers on the modern battlefield, but they will never play it as it should be played if they are content to "plough a lonely furrow" during peace, a mistake which the Engineers of more armies than one have made in the past.

* *Note.*—An article entitled "The Fourth Arm," by the late Colonel Mark Bell, V.C., C.B., A.D.C., which appeared in the *Journal of the R. U.S.I.* for December, 1897, should be read by all who are interested in this subject.

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SECTION-CLOSING APPARATUS ON A SINGLE LINE OF RAILWAY.

By Lieut. G. C. V. Fenton, R.E.

A system of closing intermediate block signal cabins on a single line of railway has been invented by Messrs. McKenzie & Holland, Ltd., and one of their installations is in use on the Cambrian Railway.

There are three block signal cabins, Talyllyn, Treifeinon, and Talgarth, and of these the second is kept open only during certain parts of the day, when the traffic is very heavy and this station is required as a crossing station. The general working of the single line is by Tyler's electric-train tablet block system, and the three stations mentioned above are equipped as ordinary tablet stations, and are also crossing stations for trains. At Talyllyn and Talgarth extra and special instruments, which will be described later on, are installed, and these make it possible at night, or with light traffic, to close Treifeinon, and to work one long section between Talyllyn and Talgarth, with a "through" tablet taken from one of these special instruments, ignoring the intermediate station altogether. A special arrangement has to be made in case any shunting is required at Treifeinon during the time the signal box at that station is closed. In order that perfect safety may be ensured it is essential that it is impossible for a "through" tablet to be withdrawn from either of the long-section tablet instruments while a "short-section" tablet is out from any of the instruments which refer to the short or intermediate sections between Talyllyn and Talgarth. Similarly, when it is required to return to the short-section working, it is essential that all the "through" tablets be returned to their proper instruments, before any tablets can be withdrawn from the ordinary tablet instruments.

At Treifeinon, when it is required to shut the tablet station, the crossing loop has to be shut, and the points set for running on one line only, and also all the signals pulled off for "line clear" in both directions, and special arrangements have to be made to overcome the interlocking in the lever frame to enable this to be done. For this purpose a special lever, which is illustrated in *Fig.* 1, is provided. When this lever is in the normal position, all the points and signals are so arranged and interlocked, so as the station can be used and worked as an ordinary crossing tablet block post, and the one key, called the "short key," can be removed from the double key lock shown at the base of the lever, and when this key is so removed, the

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lever cannot be moved from the "normal" position. To enable the lever to be moved to the middle position, it is necessary to unlock this by inserting and turning the short key, and the whole can then be moved in the usual manner to the middle position. This pulling over of the lever to the middle position removes the interlocking and enables the signalman to set the points for through

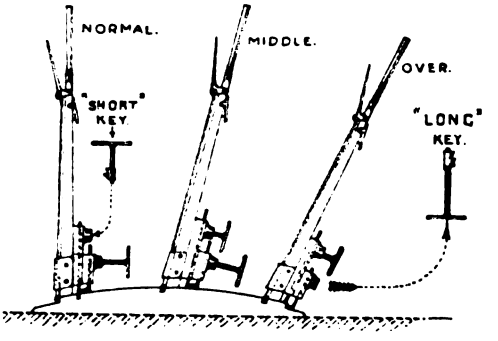
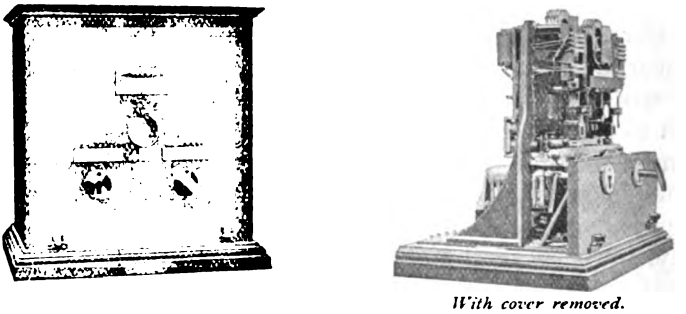


FIG. 1.

running on the single line, to cut out the loop line, and to pull off the home, starting, and distant signals in both directions. As soon as this has been done, and all the operations are complete, the lever can be pulled to the "over" position, and the other key—which is called the "long key"—can be turned and removed from the lock, and when this key is so removed, the lever is locked in the "over" position.

A switching-out instrument, shown in *Fig. 2*, is provided at Treifeinon to receive these keys when they are removed from the lever frame.



With cover removed.

FIG. 2.

When the "short key" is in the electrical instrument and turned in the left-hand keyhole, the two ordinary tablet instruments are in working between the station and Talyllyn and Talgarth, and the word "disconnected" appears in the upper space. The removal of the "short key" from this instrument disconnects the ordinary tablet

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instruments, and the insertion of the "long key" connects the special tablet instruments between Talyllyn and Talgarth, and thus switches out Treifeinon. As will be described in the method of working, no switching in or out of Treifeinon can take place without the co-operation and consent of the signalmen at Talyllyn and Talgarth, and when any tablet is out of any of the instruments in either method of working, it is impossible to withdraw the "short key" or "long key" from the instrument.

A switch instrument is also provided at both Talyllyn and Talgarth, as illustrated in *Fig.* 3. A brass handle is provided, as shown, with an

FIG. 3.

arrow on the face of it. When working with Treifeinon, this arrow points to the left-hand label, which is marked "short section," but when the intermediate station is switched out the handle is turned until the arrow points to the right-hand label, marked "long section."

Method of Working.—Considering first the ordinary working in progress—in this case the "short key" will be in the Treifeinon switching-out instrument. It is required to close Treifeinon and to work with the long-section instruments between Talyllyn and Talgarth. As soon as the signalman at Treifeinon has received the "train-out-of-section" signal for the last train that is to work over the short sections, he asks the signalmen at Talyllyn and Talgarth by telephone if they are ready to close his station, and, having received their consent, turns the "short key" in the instrument as far as it will go, and then asks them to press the plungers on their ordinary tablet instruments. When this has been done, a small disc, marked "lock off," appears at the central round indicator window in the switching-out instrument. This indicator can be plainly seen in the diagram (*Fig.* 2). As soon as the indicator shows "lock off" the short key can be removed from the switching-out instrument. Unless all the tablet instruments connected with the short sections are normal in all three signal boxes, it will be found impossible to remove the lock from the "short key," and as no train is allowed in a section without a tablet, it ensures there are no trains between Talyllyn and Talgarth when the signal box at Treifeinon is to be closed. When the "short key" is removed from the electrical instrument, all the tablet instruments are disconnected, and hence no tablet can be removed.

The "short key" is then used to unlock the special lever, as already

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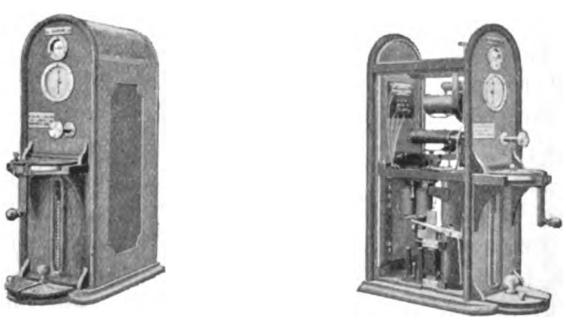
described, and enables the signalman to set the points and signals, and to remove the "long key" from the lock on the lever. The "long key" is then placed in its proper keyhole in the switching-out instrument, turned as far as it will go, and is locked in by so doing.

Each of the end switches at Talyllyn and Talgarth are provided with a small key, or "tapper," as it is termed, and the "switching-out" instrument at Treifeinon has two "tappers," all of which can be clearly seen at the bottom of the fronts of each instrument in *Figs.* 2 and 3. When the signalman at Treifeinon has inserted the "long key" in his instrument, he asks the signalmen at Talyllyn and Talgarth to hold down the tappers of their end switches, and he himself depresses both the tappers on his switching-out instrument, and this indicates "lock off" on the end switches. On seeing this indication the signalmen at Talyllyn and Talgarth turn their switches from "short section" to "long section," and then press the plungers on their long-section tablet instruments. This causes the indicator on the switching-out instrument to change from "disconnected" to "connected," and on seeing this the signalman at Treifeinon may shut up his signal box, as the closing is effected. "Through" working can now take place between Talyllyn and Talgarth. A picture of the long-section tablet instruments is shown in *Fig.* 4.



With cover removed.

FIG. 4.

These long-section tablet instruments are made to work with square tablets instead of the ordinary round ones, so that there will be no chance of confusing them, and they are also a clear indication to the engine driver to which section they refer and how far he is free to go without changing his tablets.

So long as a square tablet is out of either of the tablet instruments, it is impossible to remove the "long key" at Treifeinon by any means whatever, and hence it is evident that, until the section between Talyllyn and Talgarth is clear of trains, no alteration can take place in the position of the points and signals at Treifeinon, by the levers in the signal box. Hence it is necessary to provide special

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provisions for shunting at that station while it is closed, to avoid delay in putting off a wagon at Talyllyn loaded with goods for Treifeinon and bringing it on by a later train after the station is re-opened. This is arranged by a special toggle gear and ground frame, shown in *Fig.* 5. The siding points—which it is necessary to work for shunting purposes—are fitted with this patent toggle gear, which is shown in *Fig.* 5 in the three positions. Position A is when the points lie normal; position B shows how the points are operated from the ground frame independent of the signal box; position C

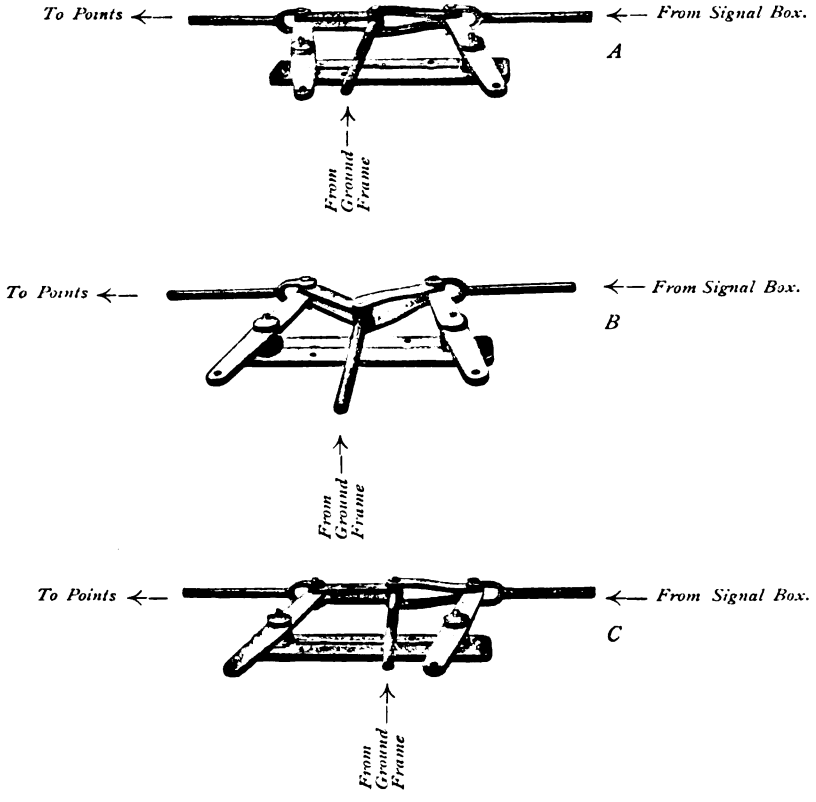

FIG. 5.

shows the points operated from the signal box direct. The ground frame contains three levers (or more, if necessary), and is fitted with a lock which can only be released by inserting into it the square tablet carried by the driver of the train on the long section. When this tablet is so placed in the lock, the levers are free to be worked from the ground frame, independent of the signal-box levers; but before the tablet can be withdrawn from the lock all the levers must be returned to their normal position in the ground frame, and this ensures all the points being properly set for the through road

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before the driver can proceed with his train on its journey. In a similar manner to the working of the ground frame independently of the signal box, the connections between the ground frame and the toggle gear are so arranged, that the points can be worked from the signal box in the ordinary way when it is open, without any extra connections or disconnections being made.

When it is required to re-open Treifeinon, the signalman at that station asks the signalmen at Talyllyn and Talgarth by telephone if they are ready to open the short sections. On receiving an affirmative reply, he turns his "long key" in his switching-out instrument as far as it will go and asks the other signalmen to press the plungers on their long-section tablet instruments; this causes the indicator at his station to show "lock off," and he is enabled to withdraw the key from the instrument. He then inserts it in his lever in the locking frame, pushes it over to the middle position, replaces all his levers in the normal position, pushes his special lever over to the normal position, and locks it by the "short key." He next withdraws that key, which he inserts in his switching-out instrument in its proper key-hole and turns it as far as possible. Finally, he asks the signalmen at Talyllyn and Talgarth to hold down the tappers of their end switch instruments, and he himself holds down those on his switching-out instrument. When this has been done, the indicators on the end switches show "lock off" and the signalmen turn the handles on these instruments from "long section" to "short section," and press the plungers on their ordinary tablet instruments. This causes the indicator on the switching-out instrument at Treifeinon to change to "disconnected," and the short-section tablet instruments are now in working order.

A very similar apparatus is provided to work on single lines of railway worked by the electric train staff, the long section being worked by the tablet instruments as described, while the ordinary electric-train staff working is used for the short sections.

The special feature of this installation is that the extra instruments do not require any additional wires, but can be fitted up on the same line wire as is used for the short-section tablet instruments.

The time taken in opening and closing Treifeinon signal box is at the most a matter of two minutes.

When required, the makers can arrange to fit the locking keys direct on to the lever frame, but the separate lever, illustrated in *Fig.* 1, is considered the most suitable arrangement when there is space for an additional lever in the frame.

A similar arrangement can be constructed to enable two or more intermediate stations to be closed if required.

The information in this paper, and the diagrams and plates illustrating the same, are given by the courtesy of Messrs. McKenzie & Holland, Ltd.

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MEMOIR.

THE LATE COLONEL GODFREY HILDEBRAND, R.E.

By COLONEL W. L. GREENSTREET, LATE R.E.

ON the 27th of last March, there suddenly passed away at his residence at Hartley Court near Longfield in Kent, Colonel Godfrey Hildebrand, Retired List, R.E., who in a quiet unostentatious way had done a large amount of highly useful work for his Queen and country.

The Hildebrand family has been connected with the Army for about a century and a-half, the great-grandfather of the subject of this memoir having come to England from Saxony in 1763, in order to take up an appointment in connection with a cavalry regiment known as King George's Black Horse. His grandfather also served in both the Essex and Sussex Fencibles, whilst his father, the Rev. J. B. Hildebrand, had, as a young man, held a commission as ensign in the 35th Foot, and as such was present at the Battle of Waterloo, for which he received the Waterloo medal.

Godfrey Hildebrand was born at Kibworth on October 18th, 1844, his father being at the time Headmaster of Kibworth Grammar School. His mother was the daughter of Capt. David Ross, R.N., who had been a shipmate of William IV., and who was provided by the Sailor King with a lucrative appointment at Deal, and, upon his death, with a tablet to perpetuate his memory in old Deal Church.

After being educated at Marlborough—where he was sent in 1859 and where he gained various prizes, and became, before he left, Captain of the Modern School, a Prefect, and, in 1861, Modern School Scholar—Hildebrand passed direct into the R.M.A., Woolwich, at the winter examination of 1861, joining at Woolwich in February, 1862.

Both at Marlborough and at Woolwich he was a member of the first cricket eleven, and at Marlborough he was also one of the football 20. This did not however interfere with his work, and in 1864 he passed out high up, obtaining his commission in the R.E. on his 20th birthday in 1864.

After leaving Chatham he was posted to Aldershot, where he remained for about nine months, and whilst there—on the 26th September, 1867—he married Margaret, daughter of William Lake,

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Esq., of Gravesend, and in the following December sailed with his wife for India, being posted, on arrival there, to Roorkee. By this time his character was probably pretty well formed, and it changed but little in after years. Combined with a high sense of duty, great straightforwardness and manliness of character, and the gift of a strong practical common sense, there was considerable intolerance of anything of the nature of bombast, unreality, or folly, together with a power of satirical expression, which made him somewhat feared by those of his contemporaries who did not know him well; and amongst those, who both knew and valued his high mental and moral qualities and his kindness of heart, gained for him a friendly soubriquet indicative of his power of applying a moral sinapism to what he thought the errors of his associates. A good example of his kindness of heart, is shown in the hospitality with which both he and his wife received the writer of this memoir and his wife on their arrival at Roorkee two years after Hildebrand had first been posted there. Not only did they rescue them from the discomforts of the Dak Bungalow, but they also hospitably entertained them until they could get properly settled.

Hildebrand was at this time an Assistant Engineer in the Saharanpore Division of the Buildings and Roads Branch of the P.W.D., having charge of various buildings and many miles of road. In the inspection of these the writer sometimes accompanied him, and was surprised at the fluency with which he conversed with the natives and the grip which he had obtained of the details of the work during the short time he had been employed upon it.

That his immediate superiors held a like view of his capacity is evidenced by their employing him at the end of 1870 to make a survey for a railway line to Roorkee, a work which was most successfully carried out, although entirely out of the line of his previous employment, and when the line was subsequently constructed by the railway engineers, they adopted Hildebrand's route with only slight alterations.

In 1872 Hildebrand was posted to the Military Works Department, and placed in charge of the Chakrata Road Division, with the duty of constructing a new military road from Saharanpore to Kalsi, at the foot of the hills, a distance of about 51 miles; and subsequently the 25 miles of partially completed hill road from Kalsi to Chakrata were added to his charge. It was an important and difficult work, involving the bridging of the Ason River and innumerable smaller streams both in the hills and the Terai, as well as the alignment and construction of a road through the Siwalic range of hills. The bridge over the river Ason, costing about $1\frac{3}{4}$ lakhs of rupees, was a fine and important work, and one of considerable difficulty, as the river is liable to sudden high floods, for which provision had to be made. The bridge consists of 10 brick arches of 50′ span, to cross the

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main channel of the river, and a subsidiary bridge of timber to cross a second channel 100′ wide ; and various difficulties regarding the soil and the influx of water into the foundations, which it was necessary to carry to a considerable depth, had to be met and overcome.

Hildebrand remained in charge of the Chakrata road till 1876, when, on the practical completion of the work, he received the thanks of Government and a step of departmental promotion, and went home on furlough.

On his return to India in November, 1877, he was placed in charge of the Umballa Division Military Works, and there too had a special work of considerable importance to carry out, viz., the water supply of the Umballa Cantonment.

He obtained his Captaincy in the Royal Engineers in December, 1877, having already been a local captain for more than a year.

Early in 1881 Capt. Hildebrand joined the Staff of the Inspector-General Military Works as Secretary of the Defence Committee, thus beginning the special fortification work with which during the rest of his service he was chiefly associated. He held this appointment till March, 1882, when he returned to England, and subsequently commanded the 12th (Depôt) Company at Chatham for a year, being then given some special duty to perform under the War Office till March, 1887. Hildebrand had been promoted Major in October, 1884, and on his return to India in 1887 he was posted to Beluchistan as Superintending Engineer. Here however he only remained till the autumn, when he was again required on the Staff of the Inspector-General Military Works for defence works, on which he was employed till he finally left India in 1891.

His services at this time were as valuable and important as they were arduous, as he had practical charge of the reorganization of the defences of India—both inland and coast—at a time when the importance of the work had come to be thoroughly recognized.

Amongst the defence schemes which passed through his hands, and on which he had to advise the Defence Committee, was that for Quetta, of which he entered carefully into all the details both of design and construction ; also the remodelling of the defences of Bombay, Calcutta, and Rangoon ; the defences of the Sukkur Bridge, commenced in 1889 and completed in 1891, and the defences of Rawal Pindi, Sher Shah, and Attock. Moreover, in addition to these larger works, the designs for numerous defencible posts in cantonments, and the defence of large and important bridges came under his review, and required his careful consideration as advising officer.

All these matters necessarily involved not only heavy and constant office work, but also a very large amount of travelling from one part of India to another.

As some of these works were in charge of the writer, it may not be out of place to mention how frequently he was impressed by

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Hildebrand's quickness—when visiting and inspecting the work—in grasping the points of a situation and in deciding upon the best way to deal with it, and also by the accuracy of the memoranda about it which subsequently came from his office, although he took nothing but mental notes, trusting to a strong and accurate memory, which never seemed to fail him.

Major Hildebrand became Lieut.-Colonel in 1891, and on his reversion to home service the same year, was appointed C.R.E., Newcastle-upon-Tyne Sub-District, where he remained till the end of June, 1894, being chiefly employed on work connected with the re-armament of the Northern Defences.

From July, 1894, to the end of 1896, Colonel Hildebrand held the appointment of Assistant I.G.F. at the War Office, and after being placed on half-pay for nearly a year, was appointed D.I.G.F. in August, 1897, a post which he held for nearly five years, *i.e.*, till the end of May, 1902, when he retired from the Service, having been promoted substantive Colonel in November, 1897.

Colonel G. Hildebrand's work at the War Office, which was principally connected with defences, and especially the re-armament of the coast defences, is pronounced by the officers under whom he served as having been in every respect excellent, and one of the most distinguished of them comments upon the prompt action and willingness to accept responsibility which lay behind his quiet manner, and the able way in which the entire business of his office was carried out. For his valuable services at the War Office he received a Distinguished Service Pension.

In the year 1906 Colonel Hildebrand was appointed one of the Directors of the Army and Navy Co-operative Society, and regularly attended the meetings of the Board, having been present at one of their meetings only two days before his sudden death. At the last annual meeting of the Society, the Chairman, Lord Ebury, referred to his loss as follows :—

"Since the financial year expired, no longer indeed than a month ago, we have had to deplore the painfully sudden death of our colleague, Colonel Godfrey Hildebrand. Although he was the latest addition to our Board, he had long established a firm hold upon our regard by the soundness of his judgment and the urbanity of his disposition."

The deceased officer was one of a family of 15, of whom six have done good service for their country in India, four of them in the Army. He leaves a daughter and several sons, two of whom are in the Army, one being a member of his father's Corps.

Colonel Hildebrand, who was a loyal member of the Church of England, and took great interest in his Parish Church and its work, was buried on the 31st March, 1909, in the churchyard of Hartley Church, in a quiet and beautiful spot close beside the home in which he had been living for the last few years.

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TRANSCRIPT.

THE FIELD TRAMWAY OF THE RUSSIAN 2ND ARMY AT HSIPINGAI.

Epitome of an article by Lieut. Freigang in the September, 1907, number of the *Eenzhenernee Zhoornal.*

DURING the latter part of the Russo-Japanese War, when the Russian troops, after Mukden, took up the main defensive position at Hsipingai, they made considerable use of field narrow-gauge tramways. Each of the three armies had a separate line which served its own particular area, and proved of great value for the transport of stores, the rapid evacuation of sick and wounded, and to some extent for the carriage of passengers.

For supplying the three armies with railway material, rolling stock and other equipment, a special depôt for light railways was established at Tsitsikar. Here the stores were brought direct from Russia and were issued on requisition to the officers in charge of the respective tramways.

The material and rolling stock for each of the three lines was identical, and in each case horse traction was used, but in the case of the 1st and 3rd Armies there was not the same urgency as in the construction of the 2nd Army line, and this latter was also much less costly than the others, because in its construction the troops were assisted neither by railway troops nor by Chinese hired labour, and also because no special assignment of horses was made for traffic purposes, but ordinary transport units belonging to the army were detailed for this duty. For these reasons especial interest attaches to the details of the construction and working of the 2nd Army line, which form the subject of this article.

In July, 1905, with the object of securing regular transport of stores for the 2nd Army, it was decided to construct a narrow-gauge tramline from Siding No. 84,* on the East China Railway, to the town of Maimaikai, and if possible to continue it towards the right flank of the Hsipingai position, as far as the village Lamatenza. The line would thus pass along the rear of the whole position of the 2nd Army, connecting points which were about 20 miles apart. In Maimaikai there were concentrated the Staff, the headquarters of various departments, and also extensive Supply Depôts.

On the 28th July the order was given to carry out a reconnaissance of the proposed line, and four days later a survey party of 14 rank and

* The 2nd Army occupied the area lying immediately west of the East China Railway.

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file under a specially detailed officer, Capt. Fetting, began this work, which took only two days, and on the 3rd August they had carried the reconnaissance to the western gates of Maimaikai. Taking the shortest practicable route, the distance covered was 10½ miles. The axis of the line was marked by 160 pickets, placed at intervals of 117 yards (50 sazhens). In spite of every effort having been taken to make circuits of hills and nullahs, this section was a very difficult one, requiring six bridges across dry nullahs, and the grading of one descent and three ascents, of which one, in the third verst, was double the normal slope. The ground was clay and in places very swampy.

Owing to delay in obtaining the necessary stores from Tsitsikar, work could not be commenced before the 16th August.

The permanent way consisted of steel rails and steel box sleepers of the Dolberg system; two rails and two sleepers were joined together to form one link, which was either straight or curved. The links were of three sizes, 1½ mètres, 2½ mètres, and the so-called normal of ·75 mètre. Shorter lengths were also issued for use in crossings, switches, etc. The rails were fastened to the sleepers by means of rivets, passing through the foot of the rail and the sleeper.

The rails of each link were fitted at one end with hooks and at the other with buttons, in each case attached to the outer side of the flanges. The links were joined together by passing the hooks of one link underneath the buttons of the succeeding link. The gauge was ·7 mètre, weight per foot of the links 22½ lbs., and height of rails 80 mms.

The cross-over ways consisted of (i.) ready-made crosses and (ii.) special switch links, the points being worked by hand. In the centre of the cross was an open space where both rails were disconnected, and herein the writer notes a fault in construction; when trolleys were travelling rapidly the wheels passed over the space safely, but with slow motion, and if the horses were pulling unevenly, it was the cause of many derailments. It is recommended that a short piece of hinged rail in the centre of the cross would be an improvement.

For rolling stock there were trolleys of two systems:—Debal and Putilov. These arrived in pieces and were put together on the spot by squads specially detailed. They consisted of iron trames decked with longitudinal planks, and fitted with low sides and 12 vertical stanchions. At both ends were small platforms, to one of which was fitted the break. The frames rested on freely moving bogies, each with four solid wheels of 12″ or 15″ diameter. The breaks were of special design, working with chains and shoes.

The difference between the Debal and the Putilov trolleys was that in the latter the uprights were of wood and in the former of iron, which made these trolleys heavier, but incomparably stronger. The Putilov break chains were better welded.

The trolley platforms measured 14′ by 4⅔′. The carrying strength of each trolley was given as 38½ cwts., but in practice it was limited to 32 cwts. (100 poods). For attaching the horses on each side of the trolley were four hooks, to which the chains of the splinter-bars were fastened by means of pins. On the splinter-bars were traces which hooked

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on to hames on the horses, and hames were also connected to the front side stanchions of the trolley. Each trolley was drawn by two horses, one on each side, this arrangement being considerably more convenient than if the horses were in front. The breakmen stood on the front platforms and the drivers on the back; occasionally one man performed both duties, but this proved to be inconvenient, leading to many collisions and derailments. On portions of the line at ground level derailments caused little harm, even if the trucks were travelling rapidly, as the wheels sunk into the earth, which acted as a brake.

In addition to the permanent way and rolling stock there were received from the depôt at Tsitsikar a complete telephone equipment for maintaining communications on the projected line of 20 miles, complete sets of carpenters', joiners', fitters', painters', and blacksmiths' tools for use in the park, also railway tools for making and repairing the line, stores necessary for equipping stations, lighting and oiling materials, and also books and forms for use of the future railway service. All of this was stored in special trucks at Siding No. 84, where a new broad-gauge siding was made especially for use of the construction parties of the narrow-gauge line.

It having been decided to construct the line entirely by military working parties, on the 21st August the G.O.C., 2nd Army, sent four battalions to the scene of the work. These battalions were distributed along the interval between Siding No. 84 and Maimaikai, and were billeted in the nearest villages.

The total distance of 16 versts was divided into four sections, each of four versts or 40 pickets. From the 12th and 6th East Siberian Sapper Battalions, parties, each of 1 officer and 10 men, were allotted to these sections as superintendents and instructors, and a separate party, consisting of the 13th Company of the 6th Rifle Regiment, with 16 Sappers was allotted to the park for unloading trucks on the broad gauge, fitting together the trolleys, and dealing with all stores as they were unloaded.

The first section (pickets 1 to 40) was considerably greater than any of the others, as it included all the terminus and park lines, and consequently, at first, only the main line and a few necessary sidings were constructed.

The following is a general description of the work:—

(1). The formation of the road. As a firm foundation was necessary, first of all drains were cut on both sides of the picket line along the whole length. These drains were 14′ apart, and each was $2\frac{1}{3}$′ wide at the top; in depth they varied up to about $3\frac{1}{3}$′. If the excavated earth was dry enough it was thrown on the road and well rammed until it was firmly settled.

In very moist places sand was used as ballast, which was fetched from the banks of the river Sancha-ho, at about $1\frac{1}{4}$ miles from Siding No. 84. If ramming and ballast failed to keep down the subsoil water, cross drains were cut and wooden pipes laid under the road, causeways were built up with brushwood, or the road was built up with planks placed both longitudinally and across the line, the paths on the sides for the horses

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being also made of planks. It was only in the first section that the swampy nature of the ground made this work necessary; in the others it was found sufficient merely to ram the earth thrown up from the side ditches.

(2). Simultaneously with this work the inclines were graded. Of the three ascents and one descent, all required quite an insignificant amount of work except the ascent in the third verst from Siding No. 84, which required such a large quantity of work that it was eventually decided to re-align the road, making a kind of zigzag.

(3). The permanent way was then laid on the completed roadway. The links were brought up on trains of trolleys. The line was laid by a special party of infantry, with a small detachment of Sappers, under an officer, at the head. If the side drains had not yet been cut, a man was sent ahead to the next picket to mark the line. Otherwise this was shown by the drains. Each man of the construction party moving in file carried a link from trolley to railhead, laid it, and then returned to the trolley on the other side of the line. The method practised in the first section of laying the rails before the side drains had been completed was soon found to be inconvenient.

(4). After the construction party there followed another whose work it was to straighten and level up the links, and ram the earth or ballast under the sleepers with wooden rammers.

(5). While this was going on the construction of bridges and level crossings was carried out. The crossings were 14 yards in width and were made of seven, or in places liable to specially heavy traffic of nine, planks laid longitudinally along the line. Of the bridges, the shorter ones were supported simply on beams laid across the gaps, but the longer bridges were made with trestles or piles. Two pile bridges, made near Maimaikai, were on the retirement of the Russians handed over to the Chinese authorities.

(6). In addition to the work already mentioned, it remained to construct the station buildings, wagon-sheds, goods-shed, forge, signal-boxes, dug-out shelters for the troops employed on the line, and, lastly, the telephone lines, of all of which further mention will be made later on in the details of the construction and working of the line.

On the 22nd August work was begun in laying the station and park lines. First of all a line was laid from the broad-gauge siding to the place decided on for the starting and arrival points, and two sidings for marshalling the trolleys loaded with the permanent-way stores for the main line. On the same day the officers in charge of the other three sections inspected their sections with a view to deciding how their work should be organized.

On this day also, by order of the Commander of Communications of the 2nd Army, the 38th Cart Transport unit arrived at Siding No. 84 with 2 officers, 156 rank and file, and 565 horses, detailed for hauling the construction trains loaded with timber and railway stores. There also arrived one company of the 54th Minski Regiment, in strength 2 officers and 128 rank and file, which formed the advanced party of a Traffic Battalion, which was to be formed of detachments from all the corps of the Army. This Traffic Battalion was destined to supply (i.) breakmen

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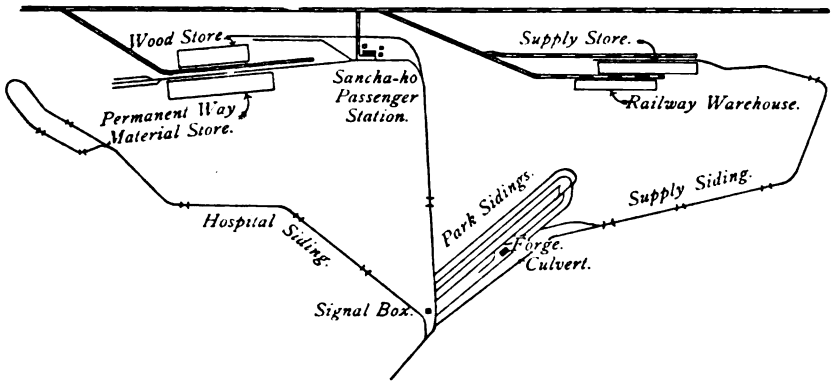
for the trolleys, (ii.) maintenance gangs, (iii.) working parties for work in the park, and (iv.) men for guard duties, in conjunction with the 13th Company of the 6th Rifle Regiment.

Siding No. 84, E. China Railway.



The head office of the line was formed considerably later, but in these first days, by the force of necessity, an improvised office was formed at Siding No. 84 for carrying out the necessary correspondence with troops and departments, for publishing orders for the following days' work, detailing working parties and notifying changes in *personnel*.

On the 23rd August the station lines from Siding No. 84 as far as the arrival points were completed, the new narrow-gauge station being named Sancha-ho, and also four park sidings, each about 600 yards in length, while the main line was carried forward to the bridge over the Sancha-ho, a distance of about 2 versts ($1\frac{1}{3}$ miles), and the excavation of the side drains proceeded steadily. That the construction did not proceed more rapidly was due to the fact that neither men nor animals were as yet accustomed to the work. As the natural ground was found to be unsuitable for carrying the line, a special carrier was arranged for drawing sand from the bed of the river to act as ballast.

On the 24th August a small bridge $15\frac{3}{4}'$ in length was built, and the line was laid as far as picket No. 40, *i.e.*, to the end of the first section. In order not to delay the trains carrying rails and ballast, most of the timber for the bridges was sent on ahead in Chinese carts, by unmetalled roads. This arrangement was carried out throughout the construction of the line.

On the 25th the line reached picket No. 60, while the roadway was completed as far as Maimaikai, and all the men thus set free were put to work on the bridges throughout the whole line.

Meanwhile railway stores continued to pour in at Sancha-ho, and as the trolleys were put together by the park working parties, more sidings had to be constructed to accommodate them.

On the 26th August the line reached the end of the second section, and a siding about 470 yards in length was laid at "Siding No. 1," a point about half-way between Sancha-ho and Maimaikai. In the first section the line was levelled and rammed and the level crossings laid down,

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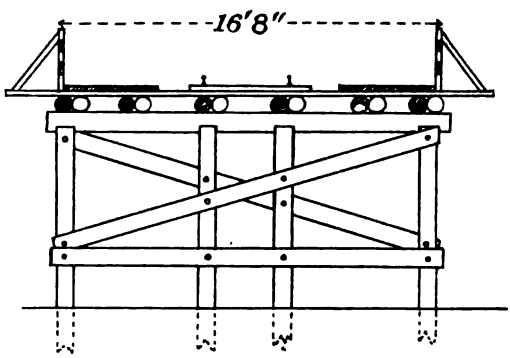
which last were found to be urgently necessary, as cross traffic was already beginning to damage the permanent way.

By this date the numbers of the Traffic Battalion had been made up by detachments of weak and otherwise unfit men to 489, and these were formed into three companies for work on the line. The establishment of officers included four infantry officers as battalion staff and three company commanders. These troops forthwith commenced their duties as breakmen and maintenance gangs.

By this time the Commander of the Army had decided that the line should not stop at Maimaikai, but should be carried on as far as Lamatenza for the conveyance of supplies and sick of the three corps stationed to the west and south-west of that village. On the 26th August a party consisting of one officer and six men began the reconnaissance of this section and completed it in three days.

On the 27th August the work of levelling and ramming was carried forward in the second section, and the permanent way was laid as far as picket 100. Here the work had to stop for a time for want of material, which was due partly to the fact that the Tsitsikar depôt was busy with the equipment of the lines of the 1st and 3rd Armies, and partly that the proportion (30 per cent.) of curved links supplied had largely exceeded local requirements. This pause gave an opportunity of energetically pressing forward the work on the bridges, and during this period the following bridges were made:—No. 3, 21′ in length, near the proposed Maimaikai Station; No. 4, a temporary trestle bridge, 22′ in length, near the south gate of the town, and a permanent pile bridge 74′ in length at the south-west angle. At the same time the ascent in the third verst was made easier, as it was found that with fully-loaded trolleys it was difficult to surmount.



Section, Pile Bridge.

In Sancha-ho station during this period the station and park lines were finally arranged and completed, and the construction of goods-shed, wagon-shed, stable, forge, signal-boxes, and various necessary buildings was begun. All these were completed in three to five days, except the goods-shed, which was still unfinished on the 10th September. These buildings were very simple huts, built entirely of wood and roofed with planks.

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As large working parties were no longer required, on the 29th August two battalions were sent to rejoin their commands.

About this time various officers with special technical knowledge of the work began to arrive from various regiments, and were gradually allotted to the duties of maintenance, traffic, and park.

On the 30th August a fresh consignment of material arrived and was unloaded, and on the 31st the line was completed up to Maimaikai Station, 12 versts (8 miles) from Sancha-ho. Here a siding, 350 yards long, was laid, and a little further on a branch was carried to the chief supply depôt, which was situated inside the town. By evening of this day the line had arrived at the southern gate.

From the 1st September the work was divided into two groups, (i.) the completion of the line up to the west gate and (ii.) the construction of the new line from there to Lamatenza.

The new line, in length nearly 11½ miles, was marked by 173 pickets and divided into two sections. Each section was placed in charge of a Sapper officer, with one technically qualified officer to help him. Four battalions from the nearest army corps were detailed as working parties and were distributed among the sections and billeted in the nearest villages. Each section was also given 15 Sapper instructors. The character of the ground was most favourable; the line ran along a plain, and only in five places was it necessary to throw small simple bridges across shallow nullahs.

On the 1st September the permanent way of the original line was completed and a pile bridge was begun, to take the place of the trestle bridge, across the wide dry ravine near the southern gate, in length 74½′.

On the new line work began in the formation of the roadway, and, by the light of previous experience, the breadth was increased from 14′ to 17½′, and the ditches were made wider and deeper.

On the 2nd September this work continued, while on the original line traffic was opened for supply loads, with the stipulation that it should not interfere with the construction of level crossings and of the station works at Siding No. 1 and Maimaikai. The line to Maimaikai was connected throughout by telephone, but at first only two telephone stations were opened—at Sancha-ho and the Supply Depôt.

On this day three maintenance gangs were formed from Sappers and the men of the Traffic Battalion, and stationed at Sancha-ho, Siding No. 1, and Maimaikai. Each gang consisted of a road master, two gangers, two skilled labourers, and 13 unskilled labourers. The road masters, gangers, and skilled labourers were Sappers, and the remainder infantry. The gangs were made responsible for keeping the line in repair, *i.e.*, levelling, packing, replacing links, and inspection of crossings and bridges. Each gang was equipped with picks, shovels, spanners, and other railway tools.

Regular passenger and goods traffic began on the line as far as Maimaikai on the 5th September, and for this a time-table was drawn up, in accordance with which two pairs of goods trains and one pair of passenger trains were despatched from each end of the line daily, the passenger trains being timed to coincide with the passenger trains on the broad gauge.

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The service of the line was managed by two experienced officers who acted as traffic superintendents, while to each of the three stations and to the Supply Depôt there were assigned, from the Sappers and infantry of the Traffic Battalion, station-masters, assistants, telephonists, and signalmen.

The composition of a goods train was fixed at a maximum of 75 trolleys, and that of a passenger train at one closed carriage and three trolleys for baggage. The carriages were ordinary trolleys covered with tarpaulins and fitted with seats.

At this time the necessity of more transport animals became evident, and a second unit (the 39th) was detailed, consisting of 1 officer, 83 rank and file, and 320 animals. It was posted at Maimaikai and worked towards Sancha-ho.

Meanwhile, on the 5th September the work on the new line which had been stopped by heavy rain started afresh, and passing over two bridges, Nos. 5 and 6, of a total length of 70′, which had already been finished, reached picket No. 106, where it was again stopped for want of material. This having been got over by moving an unnecessary siding from Sancha-ho, the line was carried on into Lamatenza itself.

From the 6th to 9th September three more bridges, Nos. 7, 8, and 9, of total length of 77′, were completed, a siding about 580 yards in length was laid at a projected station, "Siding No. 2," station huts were put up and connected by telephone with the central station Maimaikai, the pile bridge at the southern gate was finished, and the whole line was now ready for traffic. All the construction troops were sent away, and there remained only the Sappers, the Traffic Battalion, and the company of Rifles.

On the 9th September the line was opened with ceremony by the G.O.C. 2nd Army, and on that day there arrived the 1st Company, 3rd Railway Battalion, in strength 3 officers and 140 rank and file, to assist in working the traffic.

On the 10th September the last consignment of stores arrived from Tsitsikar, and a siding about 470 yards in length was laid into the local Supply Depôt at Lamatenza.

The total length of main line was about 21 miles, and of sidings about $4\frac{1}{2}$ miles. About 4 miles of the line was laid on ballast and $1\frac{1}{3}$ miles on planks. There were 12 bridges of an aggregate length of 420′, 60 level crossings, 1 storehouse, 1 wagon shed, 1 stable, 1 forge, 1 cookhouse, and 5 station buildings of various sizes.

During the construction period there were despatched along the line from Sancha-ho 393 trolleys with supply stores, 300 trolleys with construction materials, and 32 trolley-loads of passengers, each drawn by a pair of horses or mules.

As to the cost of the line, out of an allotment of 310,000 roubles, only 27,661 roubles 71 kopeks were spent, owing to the economical methods employed in the work. It should be mentioned that working pay was issued to the troops at the following rates:—Company commanders, 3 roubles per diem; junior officers, $1\frac{1}{2}$ roubles; N.C.O.'s, 50 kopeks; men, 20 kopeks. (1 rouble = 100 kopeks = 3 shillings and 2 pence).

Turning now to the arrangements for working the line—in the first

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place the head office was carefully organized under Capt. Fetting, the commandant of the line. His staff consisted of an officer in charge, a secretary for office work and correspondence, three clerks, and three draftsmen.

The park was in charge of a railway officer, with a technically-trained officer as his assistant. He had four skilled N.C.O.'s in charge of the following sections:—(i.), Timber; (ii.), permanent-way materials; (iii.); rolling stock; and (iv.), general stores. The working parties detailed from the 13th Company, 6th Rifle Regiment, and from the Traffic Battalion, were divided into gangs for the following services:—Inspectors of trolleys, fitters, carpenters, lubricating hands, smiths and hammermen, and trolley-builders.

The traffic was in charge of a traffic superintending officer, with two officers as assistants, one of whom was responsible for the telephones. The railway company supplied 5 station-masters with 7 assistants, 10 guards for luggage trains with 10 assistants, and 30 breakmen for passenger trains. The breakmen for luggage trains were taken from the Traffic Battalion.

The maintenance service was under the superintendence of a railway officer, with two technical officers as assistants. The line was divided into two sections, and three maintenance gangs were allotted to each of these sections; these gangs were quartered within their own areas, at first in tents, but from the beginning of the cold weather in specially built dug-outs with stoves. The men employed on the traffic service were always in huts, which were built with special view to winter requirements. A battalion of the Zhitomir Regiment was detailed to hold itself in readiness to assist in case of large working parties being required for extraordinary work, but their services were never required.

As the traffic had increased, the 14th and 15th Pack Transport half-units were detailed to work on the line, each with an establishment of 1 officer, 83 rank and file, and 163 animals. The transport units were then disposed as follows:—The 38th and 14th at Sancha-ho, and the 39th and 15th at Maimaikai. The 38th and 39th worked towards Lamatenza with loaded trolleys, and the other units brought back empty trains, the trolleys being linked together in twos and threes.

On the 14th September two new goods sidings were laid, one near Siding No. 1 for the supply park of the 6th East Siberian Corps, and the other to the supply park of the 1st Composite Rifle Corps.

The new time-table was arranged as follows:—For goods traffic there were run three trains daily, Nos. 1, 5, and 7, the first two of 60 trolleys each and the third of 50. No. 1 worked to the stations in the second section (10th Army Corps, the Composite Rifle Corps, and the Composite Cavalry of General Mishchenko); No. 5 worked to Maimaikai exclusively (10th Army Corps, the force of General Gregov, and the Chief Supply Park of the 2nd Army); No. 7 supplied Siding No. 1 (the 6th Siberian Corps). Trains Nos. 2 and 6 were empty return trains. For passenger traffic there were two double trains, Nos. 3 and 4, and Nos. 8 and 9, the first pair going over the whole line and the others only to Maimaikai. The trains crossed at Siding No. 1, and departures and arrivals

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synchronized with the trains on the broad gauge. In course of time, as the passengers to Lamatenza increased, a third part of train No. 9 was allowed to go over the whole line. The composition of each passenger train consisted of three covered trolleys, which would accommodate 40 men, and 7 trolleys carrying either baggage or 15 rank and file each. The goods trains travelled at the rate of 2½ to 4 miles per hour, and the passenger trains 5 to 8.

From the 14th September a journal was kept in each station, in which were entered details of every train, showing the number of trucks, horses, and rank and file, and also a register of telephone messages received and sent.

Between the 17th and the 20th September two more sidings were made, one from the Supply Depôt at Maimaikai to the quarters of the Commandant of Communications, and the other, across a newly-made trestle bridge, 25′ in length, which spanned the town ditch, to the headquarters of the army.

The construction of a line past Maimaikai made possible an excellent arrangement for transporting sick and wounded to Siding No. 84 for transfer into the hospital trains. With this object, at a point selected near the south gate of the town, a siding 230 yards in length was laid and a platform erected where the sick could be collected from the neighbouring hospitals and entrained. This was completed by the 21st September, and from this date began a regular service of hospital trains. At first it was intended to transport the sick in the empty return trains, but in view of the possibility of infection and also on account of the approach of winter, it was decided to fit up 40 trolleys specially for this service. This was done by enclosing three sides of each trolley with tarpaulins and placing felt or straw mattresses on the floor. A special hospital train, "No. 4 *bis*," was arranged to travel in rear of No. 4 passenger train.

About this time it was found that the stock of supplies which had been accumulated was sufficient to last for some time, and some of the supply trains were made available for transport of stores for the troops, Red Cross and Officers' Messes. The staff was officially remodelled, extra clerks were detailed, and also an accountant and two surgeons. The latter opened dispensaries and began sanitary inspections of men and buildings.

The line remained open for traffic until the 3rd November, during which time it is calculated that it conveyed 20,000 men, including 4,000 sick, and over 7,000 tons of stores.

The work in the park consisted chiefly of repairs to trolleys and harness. The breaks required considerable repairs owing to the defective welding of chains and the softness of the wood on the shoes. The break-platforms also suffered considerably from collisions. Damaged rails were generally replaced and not repaired, as there was a large reserve of spare links. Carpenters' work included the fittings of passenger and hospital cars, furniture, etc., for stations, offices, and quarters.

The cost of working the line for two months amounted to only 5,149 roubles, out of an allotment of 34,000 roubles.

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On the 4th November, in consequence of the departure of the army to the north, the dismantling of the line commenced.

Two infantry battalions were detailed to assist in this work, and were allotted one to the railhead and the other to Siding No. 84. The dismantling was divided into daily tasks of 5 to 6 versts each, and separate parties were told off to dismantle (i.) the line, (ii.) the station buildings, bridges, and level crossings, and (iii.) the telephone line.

As a protection against the Khankhuzes, now that the troops had departed, two sotnias of Orenburg Cossacks were detailed, and these patrolled along the line and to south of it by day and night. By night, infantry outposts and patrols were also posted. The command of the rear guard was entrusted to General Tolmachev.

The method of loading up the permanent way was as follows:—A train was brought up and its trolleys were placed along the line at intervals of 60 links, measuring back from the railhead. All except the head one were lifted off the rails and placed on the side of the line. The links were then dismantled until the first truck was loaded, when it was sent down the line and the next one lifted on the rails and loaded up in its turn, and so on. In this way the whole line was dismantled in seven days, only sufficient sidings being left in Sancha-ho station to accommodate trucks which were required for transferring the stores to the broad-gauge siding.

The work of the battalion stationed at Siding No. 84 included unloading, sorting and loading stores for return to Tsitsikar, and afterwards the dismantling of the trolleys.

After this the men of the Traffic Battalion were gradually returned to their units, and the Railway Company and other corps departed, and finally on the 23rd November a small office staff moved with the commandant to Bukhai station, where the work of making up reports, accounts, etc., was carried out. This was finally completed by the 17th December.

In conclusion, the following points may be mentioned as having been brought out by practical experience in the working of this line:—

(1). These lines may more safely be laid in continuation of, rather than at right angles to, the lines of communication of an army, since, in case of an unexpected retirement, in the former case it is more easy to remove the stores, or at any rate the rolling stock.

(2). Troops liable to be employed on this work in war should be instructed in it in peace time.

(3). The permanent way should be laid at ground level as far as possible, rather than on embankments or in cuttings. It is better to work round slopes than through them. Side drains are of course necessary.

(4). When preparing the surface it should be well rammed.

(5). The use of ballast is only necessary where the ground is swampy.

(6). The best method of carrying the line over marshy ground is on planks. Here the planking need not be continuous, so long as each plank supports at least two adjacent sleepers.

(7). The width between drains should not be less than 17½'.

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(8). The earthwork must be completed before the line is laid.

(9). The class of rails used was too light, and consequently the rails frequently became bent and the couplings disconnected. An improved coupling is suggested for the rails, in which, in addition to the hook on the outside of the rail, there should also be a projecting plate on the inside, so that the flange of the succeeding rail should fit between this projecting plate and the hook.

(10). The alteration required in the crossover ways has already been mentioned.

(11). All bridges must have a breadth of roadway of $19\frac{1}{4}'$, and double planking for the horses is obligatory. The road-bearers may be so laid that the links of the permanent way may rest directly on them. In case of large pile bridges, the preparation at first of temporary trestle bridges is necessary, in order to cause no delay to construction of the line.

(12). A combination of the two kinds of trolleys might be designed which would contain the advantages of both. This would include the breaks of the Putilov trucks and the iron standards of the Debal. Wooden standards are invariably stolen for firewood.

(13). Special trucks for carrying long spars should be provided.

(14). An arrangement is suggested by which the horses could more readily be unhitched and reversed. The ends of the splinter-bar could form hooks which would catch rings on the trolleys and be secured to prevent them from falling out.

(15). Special stretchers or mattresses for serious cases of sickness should be provided.

(16). The practice of sending trains in pairs for ordinary traffic is recommended, but in a retirement, when trains are very large and little punctuality is required, it was found best to send them singly.

(17). Trains worked by 30 or more men should be in charge of officers.

(18). In all large stations, where there is much goods and passenger traffic, the station-masters should be officers.

(19). There should be two men to each truck, as the driver cannot manage the break.

(20). All traffic on these lines should be conducted if possible by day. If night work is obligatory, passenger and heavy goods traffic should be reduced to a minimum, and passenger trains should always precede goods trains. Special trains should never be allowed.

(21). A single telephone is sufficient for the whole line, but a central exchange station is obligatory.

(22). A special establishment of horses is not obligatory, but all the transport establishment must be placed directly under the orders of the commandant of the line, both for discipline and supply.

These notes are from $2\frac{1}{2}$ months' experience of working a horse-traction tramway; possibly longer experience might have revealed further requirements.

F. E. G. SKEY.

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III Army

KUANDYATUN

16th Corps

Boundary 2nd & 3rd Armies

R. Chaosuntai-ho

CHANGTUN

1st Composite

LAMATENZA

Siding

Rifle Corps

Supply Depot 1st Comp. Rifle Corps

10th Corps

MAIMAIKAI

Army Staff

Supply Depot

Maimaikai Sta.

Hosp.l Siding

To Sta. Godzyadan

Siding No. 1

6th Siberian Corps

KARDYA

R. Tyaodzi-ho

R. Tyaodzi-ho

Siding No. 84

2nd

8th Corps

I Army

YINGIA

BAMIENCHEN

R. Tsaisi-ho

SHILIPU

HSIPINGAI

Hsipingai Sta.

R. Tyaodzi-ho

Boundary

DAVA

From Pabaotun

GENERAL PLAN OF THE HSIPINGAI POSITION OF THE 2ND MANCHURIAN ARMY.

4 0 4 Versts

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REVIEWS.

SOME NOTES ON SUB-DRAINAGE AS APPLIED TO THE ANTI-MALARIAL CAMPAIGN ON THE ISTHMUS OF PANAMA.

THE following are a few notes on an article by H. Simms in the *Annals of Tropical Medicine and Parasitology*, issued by the Liverpool School of Tropical Medicine in February, 1909:—

The article contains the results of the practical application of sub-drainage in the Isthmus of Panama. The climatic conditions of that region are unusual, the rainfall averaging 180″, and the rainy season lasting from May to December. The methods used for ordinary agricultural drainage are unsuitable.

For anopheline extermination, the main object is to remove surface water and all puddles formed by "seepage water." All wet places should be thoroughly dried every 10 days.

Up to 1905 every effort had been directed towards the extinction of yellow fever, and any drainage which had been attempted was for the purpose of removing large bodies of water. The camps and neighbourhood were at this time swarming with anophelines, and the percentage of sick in December, 1905, was 9·36. Systematic measures were now commenced, to endeavour to reduce the casualties from malaria. These measures consisted of:—

1. Cutting all vegetation growing in wet places.
2. Confining all water to open channels, and the copious use of crude oil.
3. Screening of buildings and cutting all vegetation within 600′ or 700′ of houses, this distance being considered to be about the limit of flight of the anophelines.

The maintenance of the open ditch system was found to be very costly on account of the damage done by heavy rains, the rapid growth of tropical vegetation, and the necessity for the lavish use of larvicides. It was therefore decided to introduce some more permanent method, which would be cheaper to maintain. "Tile" drainage was the method selected, and the work was started at the end of 1906.

The following table indicates the percentage of employees suffering from malaria in the months of March and August, 1906–7–8. The fall in the percentage in the latter year, when the drainage work was well under

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weigh, is very marked. March is the end of the dry season and August the month in which the fever rate is highest.

Year.	March.	August.	Annual Average of Deaths per 1,000, based of Returns for August.
1906	6·32	9·01	10·55
1907	4·16	5·33	5·05
1908	1·23	3·43	2·44

It is stated that the breeding areas which give the greatest trouble are "seeps" on the sides and at the bases of the hills, and from water following small areas of impervious strata. Such places are difficult to locate, and if overlooked will breed enough anophelines to seriously affect the health of any camp in the vicinity.

The general problem seems to have been to lay a pipe so that a considerable torrent of water could pass over it without causing erosion, and also so that the pipe should be able to carry away every drop of water in a few hours after a flood. Such pipes had, of course, to be capable of passing a considerable amount of silt.

The "tiles" or pipes used were of three sizes, 4", 6", and 10", porous and unglazed. It was found that a 6" pipe would pass silt at a slope of 1 per cent. and a 10" pipe at one of ½ per cent. If a flatter slope were given, flushing would be necessary. If the "tiles" were laid for "seepage" water, and not on main lines, a slope of ½ per cent. was found adequate.

The main pipe, or "tile" line, would usually follow the course of some small stream, the feeders from the side seeps joining into it. In laying the main line, care should be taken to straighten it as much as possible, and thereby increase the fall in the pipe. If this fall however exceeds 5 per cent., it was found desirable to introduce breaks or "falls" so as to reduce the velocity of the surface flow in flood time.

The "tiles" should be 2' 6" below the bed of the stream, carefully graded with joints ⅛" to ¼" opening. They should be firmly bedded in crushed rock on all sides, with at least 4" of this material on top.

If the scour is great, extra precautions may be necessary. All branch drains should be laid the same way and connected to the main lines by Y junctions. Care must be taken to deal with roots of trees which may interfere with the pipes.

Great care is necessary, before commencing work, to accurately determine the direction of the flow of the water below the surface. This should be done by means of borings or trial pits. This is an important point, as it is essential that all water should be intercepted. In some cases, if the line of fall is very steep, parallel lines of pipe laid deep and close together will be required.

Cost.—Transport and wages are expensive on the isthmus. A good labourer receives $1.80 a day (7s. 2d.). Sometimes the work laid in inaccessible valleys, and roads had first to be made; and in some cases rock had to be transported by train. The average cost of the "tiles" laid worked out to 35 cents a foot (1s. 5d.), of which 1s. 3d. represents the first cost of the tile, leaving a balance of 2d. for labour, etc.

'G.W.'

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THE LIFE OF MAJOR-GENERAL SIR CHARLES WILLIAM WILSON, K.C.B., ETC., R.E.

By COLONEL SIR CHARLES M. WATSON, K.C.M.G., ETC.—(Murray, 1909).

The life of Sir Charles Wilson well deserved to be written, and no one could be more competent to write it than Sir Charles Watson. He was not only a warm personal friend, but has an intimate knowledge of Egypt and of the events in which Wilson played so considerable a part. The story is told in a plain, straightforward way, with discretion, but with no undue reticence, and the author is able to borrow freely from Wilson's diaries and letters. These extracts add much to the vividness and the literary charm of the book, for even as a young subaltern making entries in his diary, Wilson wrote with force and style. There is a page of admirable description of his journey across the Isthmus of Panama, on his way to British Columbia, where he was to be employed on the Boundary Commission of 1858.

Wilson was not one of the men who "have greatness thrust upon 'em" by the happy accident of being concerned in some memorable feat of arms. On the contrary, it was his ill-fortune not only to have his name associated with a deplorable failure, but also to have to meet a most discreditable attempt to make him the scapegoat.

In the course of his career his employment was singularly varied, but this was not because of his own restlessness or ambition. Although his services were in constant demand, because he did so well whatever he had to do, the only case in which he seems to have volunteered them was for the survey of Jerusalem in 1864. This was a very modest enterprise at the outset. It was a mere preliminary to a better water supply, which Miss Burdett-Coutts wished to provide, and it was not to cost more than £500. The officer in charge of it was to pay his own expenses, Turkish obstruction was anticipated, and it is not surprising therefore that several men had already declined to undertake the work before Wilson offered himself. He had been at school at Liverpool under Conybeare and Howson, the joint authors of *The Life and Epistles of St. Paul*, and his interest in the problems which Palestine presented, seems to have been largely due to Howson's influence. But things were apt to grow in Wilson's hands, and an immediate result of his work at Jerusalem was the establishment of the Palestine Exploration Fund, of which he was one of the leading spirits for the rest of his life.

In 1869 he was placed in charge of the Topographical Department at the War Office, and, when it was separated from the Ordnance Survey in the following year, he was made Director of it. The only officer employed under him at that time was the present Lord Cromer. Wilson set himself to make the Department more adequate to the work required of it, and it is characteristic of him that, in the scheme which he submitted to Mr. Cardwell in 1872, he proposed that a general officer should be brought in over his head. This was the beginning of the Intelligence Department, in which

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he continued to serve till 1876, when he was appointed Director of the Ordnance Survey of Ireland. It was while he held this latter appointment that he was employed as Consul-General in Asia Minor and in connection with the Expeditions to Egypt and the Sudan.

The three chapters which deal with the Nile Expedition, are those to which readers will be apt to turn first. They give a full and lucid statement of what took place, supplementing Wilson's own book, *From Korti to Khartum*, and clearly indicating the causes of the failure. In Wilson's opinion there were four main causes—the delay of the British Government in making up its mind; the deference shown to the Mudir of Dongola, who did his best to obstruct the expedition; mismanagement in sending up the boats; the insufficient supply of camels, which involved a 10 days' halt at Jakdul. "During October, November, and December the purchase of camels was stopped and recommenced about half-a-dozen times," and when they were needed for the desert column, there were not enough of them. In August Lord Hartington had written to Mr. Childers:—"I think that in itself Wolseley's appointment may be an economical measure. He has a great aversion to embarking on a large expenditure for land transport, which would be the most costly of all preparations."

As regards the delay at Gubat, for which Wilson was responsible, Sir Charles Watson shows not only that there was good reason for it, but also that there is no ground for supposing that it affected the result. "Had the steamers left Gubat three days earlier, Khartum would have fallen three days earlier. That would have been all the difference." Even if Wilson had been able to carry out his instructions to the letter—to show the redcoats in the streets of Khartum, and bring them away, leaving three officers to assist Gordon—it would not have enabled the starving garrison to hold out for another six weeks. Lord Hartington, who had the best means of judging, entirely exonerated Wilson and praised him highly. So did Sir Lintorn Simmons, who characterized with refreshing vigour "the dastardly act" of trying to make a scapegoat of him, and whose letter, printed now for the first time, is well worth reading.

It is needless to dwell on the good service which Wilson rendered subsequently at the head of the Ordnance Survey and as Director-General of Military Education. Repeated visits to Palestine and three years of employment in Asia Minor had given him an almost unequalled knowledge of that part of the Turkish dominions. He edited Murray's handbook of it, and the list of his lectures and papers, mostly connected with this subject, occupies more than three pages of this book.

Sir Charles Watson has earned the thanks of his brother officers by this valuable addition to the gallery of Corps Worthies.

E. M. LLOYD.

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NOTICES OF MAGAZINES.

Journal des Sciences Militaires.

March 15th, 1909.

The article on 3-gun batteries is continued. The batteries should be worked in 3-battery groups. The ammunition wagons should be common to the group and be allotted to the batteries composing it as needed, as, according to French Staff ideas, "certain batteries, which cannot be chosen in advance, will have to maintain a fire far heavier than peace practice would lead one to suppose." It will be impossible to replace casualties till the first burst of fire is over, and on account of the small numbers actually engaged as gun crews, this burst will not be of long duration. Transport should be organized on a battery or a group basis, under a special transport officer, thus setting free the battery commander to attend entirely to his battery.

Turning to higher organization, "advanced guard" artillery is suggested. It is a principle that artillery should be pushed into action to cover the infantry advanced guard from the beginning of an action, provided that there are enough troops of other arms to act as escort. This means that a general may legitimately bring his second division artillery into action in support of his first division, before any of the second division infantry is engaged. Continuing this idea, the frontier corps might reasonably be supported by the artillery of corps from the interior, while the latter are being mobilized and brought up. More particularly this applies to reserve divisions, of which the most to be expected is that they will crush the enemy by sheer weight of numbers when brought up at the decisive moment. A reserve is intended to be used to the last man in the forward movement. Even if these divisions had artillery, there would be no room to bring it into action with them. If there were, very little could be expected of reserve artillery unfamiliar with their guns, their officers, and each other.

It is said that one of the lessons of the Russo-Japanese War is that Suvaroff's doctrine of the decisive effect of the bayonet has been proved wrong, when compared with Napoleon's remark "Fire is everything, the rest nothing," even though the latter referred more particularly to artillery.

French, Germans, and Japanese in their new regulations agree that infantry is the principal arm in action, and that the offensive is essential to victory. In infantry attacks, "morale" is the first factor in success. It forms three-quarters of a soldier's value.

An illustrated article on the periscope for the use of field artillery is given. As artillery now makes such great use of indirect fire, a periscope is considered almost a necessity to get good results.

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April 15th, 1909.

A further instalment of "Automobilism" considers its application to ammunition transport. Remembering the enormous consumption of ammunition in Manchuria, it is necessary to have a large supply close at hand. The French carry 500 rounds per rifle and 500 projectiles per gun. The principal park for supplying this amount is kept about a day's march behind the main body, so as not to hamper its movements. After an action the ammunition wagons must cover this distance twice—full going, and empty returning—and, if possible, the double journey should be done in one march. Twenty-five miles is the limit for horse-drawn vehicles, and these therefore must not be more than about 12½ miles distant from the troops. The use of motors would increase this limiting distance considerably.

The reduction possible by substituting motors for horses, in the various services mentioned in this series of articles, would be about 2,000 men and 4,000 horses. The cost would be about £400,000 per army corps, to buy a complete plant, without any system of using civilian vehicles. To get full value from such a service, it would be desirable to have a special section of the General Staff, which would make all the necessary arrangements.

An attempt has been made in Austria to follow dirigibles with motors, but the former easily outstripped the latter. The same nation has tried a three-wheeled motor cycle for laying telegraph wires.

Following the lead of Brazil and Chili, the Argentine Republic has adopted the Krupp model of quick-firing field artillery, in spite of a report, by a commission of officers, in favour of the French Schneider model. In the Brazilian tests the French gun was unfortunately destroyed in a fire, and could not be replaced in time. Later however the two types competed in the Peruvian trials, which resulted in the French gun being chosen. In the case of Chili, the officer, in whose hands the choice rested, was of German origin. Mexico and Bolivia have adopted the French gun, and Uruguay has not yet finally made its choice.

General von Bernhardi has lately published a book on cavalry. The principal reforms he suggests are:—(1), More initiative for cavalry commanders; (2), a less definite allotment of cavalry, so as to allow corps engaged on siege work, for example, to send their cavalry to join other corps; (3), more open formations; (4), dismounted action; (5), more modern regulations for drill, etc.—suppressing those movements which are impossible off the parade ground. These changes should all be based on Frederick the Great's maxim, "Prussians should attack always and everywhere."

May 1st, 1909.

There is a further instalment of the article on "3-gun batteries" in this number. The ministerial solution of the artillery question is a compromise. The number of guns is increased from 92 to 120 per army corps. They are organized in three regiments—two 9-battery divisional regiments and one 12-battery corps regiment. There is also some talk of forming "reinforcing" batteries with a very weak regular nucleus.

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The two schools of thought, between which the compromise has been made, are those who compare the French and German artillery (i.), by batteries, (ii.), by guns. Since a Commission has declared a 4-gun superior to a 6-gun battery, the first party are satisfied with opposing 24 French 4-gun batteries to 24 German 6-gun batteries. The second party however clamours to increase the batteries to six guns, and to thus equal the total number of guns possessed by Germany. They forget the difficulties of ammunition supply and the impossibility of one man commanding six quick-firing guns in action. There would also, at times, be considerable difficulty in finding space to bring 144 guns per corps into action. The various theoretical solutions propounded, such as two lines of guns, one firing over the other, are hardly practicable in a "war of manœuvre," as opposed to a "war of positions." Many people, too, when comparing the French and German methods of fire, forget the considerable differences in the two equipments.

The present instalment of "Instruction of an Infantry Regiment," deals with night fighting. When considering European warfare too much stress should not be laid on the many night attacks in South Africa and Manchuria. In both cases movements were much slower than would be the case in Europe. Large bodies of troops will probably make preparations during the night for an attack at dawn, but actual night fighting will only take place between small bodies such as outposts, in order to achieve special missions, such as seizing important points.

The principal characteristic of attacks at night will be simplicity in their plan and object. Complicated manœuvres are impossible, although false attacks to distract the enemy's attention from the threatened point will be useful. Cyclists are the best means of communication on account of their speed and silence.

Defence at night must be carefully arranged for. It is not a bad plan for outpost troops to occupy momentarily the positions which they would take up in case of a night attack, when going on duty. All ranks would thereby become acquainted with them. All arrangements ought to be made by daylight and not left to the hurry and confusion of an attack. Wire entanglement is the best obstacle. Fire, though practically prohibited to the attack, is the best means of defence; care should be taken to keep it low. The best method of meeting an attack is by a counter-attack, as a small determined party can easily defeat a much larger body at night by surprising them in flank. A trick, recommended by Marshal Bugeaud, is to occupy at night a position a little in rear of that occupied by day, so that in case of attack the enemy will strike uselessly at the day position and lay himself open to surprise from the retired night position.

May 15th, 1909.

A short account of the reorganization of the Russian Army is given. "The Committee for the Education of the Troops" has already published several training manuals and has others in preparation. The artillery section is studying a manual on the use of hand grenades, and the question of field search lights has been considered by the Inspector-

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General of Engineers. Each army corps is to have three 75-c.m. projectors, and each infantry regiment a 35-c.m. projector. A 75-c.m. projector is to be allotted to every brigade of horse and field artillery. The latter are to practise in peace time firing over the heads of their own infantry. Officers' pay is to be increased. The syllabus for cadets has been improved, and a foreign language is now compulsory. In European Russia it is German, in Siberia and Turkestan, English. An article on mines, based on the Siege of Port Arthur, has appeared in the Russian Engineer Journal. The most important part to protect by galleries is the caponier. The best depth for these is about 24′, as this ensures freedom from chance interruption by howitzer shells. If money is available, another system 48′ down is desirable in some cases. To carry out mining operations, it is estimated that, for a face consisting of three forts, 150 miners are needed. If work is to be carried on day and night, 450 men in three shifts should be detailed.

The series of articles on the 3-gun battery is concluded. The proposals are summed up. The tradition of allotting a fairly even proportion of guns to each army corps, and spreading them evenly over the country, should be abandoned. The artillery should be concentrated on the frontier, and told off to the various corps as circumstances on the spot render desirable. In action the guns should be divided into two groups, one to overwhelm the hostile artillery, the other to support the infantry attack. The Japanese have come to the conclusion that reserve units of artillery and cavalry cannot be relied upon. The 3-gun battery organization could be easily expanded in war to provide two batteries, per peace battery, in which all important positions would be filled by regulars.

"Combination" is the subject of this instalment of "Instruction of an infantry regiment." "All tactics," according to Dragomiroff, "resolve themselves into combination in action." This was recognized by both Kuropatkin and Oku in their instructions to their men. The sole object of the other arms is to help the infantry to accomplish their task under the most favourable circumstances. On the march, cavalry is the principal arm in reconnaissance. Infantry supports should be under the cavalry commander. When attached to a column however so as to give local protection, the cavalry takes second place, and should be disposed as the column commander wishes. On outpost duty cavalry should be under the orders of the outpost commander; but in practice the squadron attached to each infantry division has usually too much to do to be of much use on outpost duty. The Japanese system of small bodies of infantry—to which a few cavalry are attached to act as "points," flankers, and orderlies to keep touch and carry messages—is best in circumstances where there is a lack of cavalry. In action cavalry will find plenty of opportunities for surprising shaken infantry, guns without sufficient escort or on the march. Probably a squadron is the largest body which can be usefully worked together for such exploits.

H. L. WOODHOUSE.

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NATURE.

April, 1909.

PANAMA CANAL (*p.* 197).—For some time past alarming reports have been in circulation as to the work on the canal, and especially as to the stability of the proposed great dam at Gatun. Three years ago it was settled that, taking everything into consideration and under the special conditions that prevail on the Isthmus of Panama, it was desirable that the canal should have locks in preference to being made throughout at the sea level. About three months since, a Commission was appointed by President Roosevelt to enquire into the safety of the Gatun dam and generally to report as to the works. The findings of this Commission are a full endorsement of the scheme and works as now being carried out, and an expression of confidence in the engineers entrusted with this work. The dimensions of the locks, as finally settled, are to be 1,000′ in length and 110′ in width. The cost of the canal is estimated at 72 millions sterling, whereas a sea water-level waterway would cost upwards of 100 millions, and would take several years longer to construct than the lock canal, which, it is hoped, will be finished in about five years. About 50,000 men are now employed, and yellow fever and other diseases common to a tropical swamp have almost entirely been stamped out.

MOUNT WILSON OBSERVATORY, CALIFORNIA (*p.* 209).—The 60-inch reflecting telescope has now been erected at Mount Wilson. The mirror was successfully cast in France, and figured and polished at Pasadina. The difficulties connected with the transport of the mirror and mounting, to the summit of Mount Wilson, were great. The telescope is now mounted in a 50-foot dome. Dr. Ritchey is at present on a visit to Europe, arranging for the casting of the disc for a still larger reflector—100″ in diameter—which has presented considerable difficulties.

THE ÆTHER OF SPACE (*p.* 322).—By Sir Oliver Lodge.—When a steel spring is bent or distorted, what is it that is really strained? Not the atoms—the atoms are only displaced; it is the connecting links that are strained—the connecting medium—the æther. Distortion of a spring is really the distortion of the æther. Matter can only be moved. Contact does not exist between the atoms of matter as we know them; it is doubtful if a piece of matter ever touches another piece, any more than a comet touches the sun when it appears to rebound from it; but the atoms are connected, as the comet and the sun are connected, by a continuous *plenum* without break or discontinuity of any kind. Matter acts on matter only through the æther. But whether matter is a thing utterly distinct and separate from the æther, or whether it is a specifically modified portion of it—modified in such a way as to be susceptible of locomotion, and yet continuous with all the rest of the æther, which can be said to extend everywhere, and far beyond the bounds of the modified and tangible portion—are questions demanding, and it may be said in process of receiving, answers. (The whole of this article is most interesting and well worth reading).

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TRANSATLANTIC WIRELESS TELEGRAPH (*pp.* 233 *and* 264).—Professor Marconi has published in the above-mentioned two numbers of *Nature* a detailed account of the invention and progress of the new telegraphy. In seven years the useful range of "wireless" has increased from 200 to 2,500 miles. He gives details and sketches of the new station at Glace Bay. The aerial was large and consisted of a vertical portion in the middle, 220′ long, supported by four towers and attached to horizontal wires—200 in number—each 1,000′ long, extending radially all round, and supported at a height of 180′ from the ground by an inner circle of eight, and an outer circle of 16 masts. (The natural period of this aerial gave a wave length of 12,000′). The capacity employed was 1·8 microfads, and the spark length $\frac{3}{4}''$. Improvements have been made by the adoption of air condensers, composed of insulated metallic plates suspended in air at ordinary pressure. These prevent the dissipation of energy, and a very appreciable economy in working, resulting from the absence of breakages in the dielectric, is effected.

Messages can be transmitted across the Atlantic by day or by night, but there exist certain periods, fortunately of short duration, when transmission is at times ineffective. This occurs in the morning and evening, when, due to the difference in longitude, daylight or darkness extends only part of the way across the Atlantic, the received signals are weak and sometimes cease altogether. It would appear as if illuminated space possessed, for electric waves, a different refractive index from dark space, and that in consequence the electric waves may be refracted and reflected in passing from one medium to the other. This difficulty would not be experienced in telegraphing over equal distances from north to south.

In the same manner as there exists periods when signals are unusually weak, there exist other conditions, especially at night, which make the signals abnormally strong.

W. E. WARRAND.

REVUE MILITAIRE DES ARMÉES ÉTRANGÈRES.

January, 1909.

The operations immediately before the Battle of Liao-Yang, with an appreciation of the situation just before the battle, are the part of the history of the Russo-Japanese War studied in this number.

MILITARY BALLOONING IN GERMANY (*continued*).—The conditions to be fulfilled by Parseval No. 2, before the Government would purchase it for military use, were:—

1. That it should accomplish a 10 hours' journey.
2. That it should be able to rise to an altitude of 1,500 mètres, and remain one hour at that height.
3. That it should have a measured speed of 11 mètres per second (about 25 miles per hour).

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4. That it should be possible to inflate it anywhere without the need of a shed to protect it.
5. That it should be possible to carry it rapidly and easily from place to place before inflation, or after having been deflated.

During the trials the balloon was carried on carts to the inflating apparatus, and was ready to start in 4½ hours. The maximum speed attained was 26 miles per hour, and it obeyed the horizontal rudder very readily.

The following description of the Gross No. 2—taken from the *Allgemeine Automobil Zeitung*—is given. The balloon possesses a keel (*Kielgerust*), which is suspended from the gas-bag, and in the centre of which is carried the propeller. The new position of the propeller is regarded as a great improvement upon French dirigibles, in which it is fixed to the car. This had a tendency to turn the balloon over lengthways, which had to be counteracted by the vertical rudder. The propeller is of aluminium and has three arms, and power is transmitted to it by means of a steel wire belt, which is lighter than gearing. A ventilator, destined to supply the air-bags with air, is also situated on the keel, and an arrow-shaped prolongation of the keel, towards the rear, serves as a steadying surface and also carries the horizontal rudder. The principal steadying surfaces are placed towards the rear of the balloon at the height of its axis, and the vertical or elevating rudders are also attached to the keel towards the front of the balloon.

The third type of dirigible is the rigid or Zeppelin type. The history and description of each of the successive balloons, as well as an outline biography of Count Zeppelin himself, are given. The Count's first ascent took place in 1863 in a captive balloon belonging to the Army of the Mississippi; his studies on dirigibles date from the Siege of Paris in 1870, and his experiments, from his retirement from the Würtemberg Army in 1890. His first dirigible saw light in the summer of 1900, but after three successful ascents, in which a speed of 7½ mètres per second was reached, lack of funds put an end to the experiments. In the winter of 1901 the Kaiser awarded Count Zeppelin the Order of the Red Eagle (1st Class), and gave him the help of the Ballooning Section.

It was not however till November, 1905, that the second balloon came into existence, but unhappily, after a successful ascent in January, 1906, when the dirigible landed at Leutkirch, it was destroyed by a violent tempest during the night.

The undaunted inventor however began building his third model the same year, and received a grant of £25,000 from the Reichstag. His first ascent in it took place in September, 1907, but in December a violent storm sunk his floating shed, damaging the balloon. By the time it was raised, May, 1908, Zeppelin No. 4 was being built.

This dirigible is 135 mètres long and 13 mètres in diameter, and has a volume of 15,000 cubic mètres. Each of its Daimler motors generates about 114-H.P. It has two cars and can carry six passengers. It is steered in a horizontal direction by means of two vertical surfaces symmetrically situated at either end of the gas-bag, and vertically by

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means of a sliding weight. Two large horizontal surfaces on a level with the longer axis of the balloon serve as steadying surfaces.

The conditions to be fulfilled by this dirigible were :—

1. To accomplish a journey of at least 400 kilomètres (250 miles) in 24 hours.
2. To land on terra firma (not water) at the end of the journey.
3. To carry sufficient water, oil, and petrol on board for the whole journey.
4. To attain an altitude of 1,200 mètres at least, so as to be out of gun range.

On the 29th June, 1908, the balloon made a 12 hours' journey over Switzerland with a speed of 35 miles an hour. Finally, on the 4th August, the 24 hours' journey was accomplished and the airship came to rest in a meadow near Echterdingen, where a few hours later it was completely destroyed by a gale. In spite of this cruel blow, in the very hour of his success, the intrepid Count was not downhearted, but set to work at once to reconstruct a new model. On the 7th November, accompanied by the Crown Prince, he made the first ascent ; a few days later the Emperor himself was present at the trials, and conferred on Count Zeppelin the Order of the Black Eagle ; on the 11th the *Berliner Tageblatt* announced that Count Zeppelin's invention had been purchased by the German War Office.

Thus on the 1st January, 1909, there were six balloon sheds in the possession of the German Army.

Two new types of airships are being constructed by the Siemens-Halske Society and the Technical College of Danzig, and a society known as the "Deutscher Luftschiffer Verein" has been formed at Mannheim, with the following objects :—

1. To make Germany the leading nation in the matter of aerial navigation.
2. To create ports for airships all over the Empire.
3. To carefully look out for, and improve such natural refuges against storms as exist for airships, and to build artificial ones.
4. To seek to make use of balloons for scientific aims, or for the exploration of unknown lands.
5. To prepare special maps for the use of aerial navigators.

Amongst the uses made by the Germans of their military balloons, the experiments made on throwing explosives from airships on the Tegel Range are mentioned, and the article finishes by quoting from the *Kriegstechnische Zeitschrift* on the "Tactics of Airships," a review which has already appeared in this paper.

THE STATE OF THE CHINESE ARMY IN JULY, 1908.—The Chinese Army consists of :—

A.—New organization :—

(*a*). The regular army, or Lou-kiun.
(*b*). The police, or Siun-djin-kiun.
(*c*). The auxiliary police forces, or Siun-fang-toué.
(*d*). The imperial guard, or Hou-wei-kiun.
(*e*). The gendarmerie, or Djin-tcha-toué.

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B.—Old organization :—

(*a*). The Manchu Army of the Eight Banners.

(*b*). The Chinese Army of the Green Standard.

(*c*). The Mongolian and Tibetan Militia.

(*d*). The rural militia.

(*e*). The special guards of the mandarins.

In time of peace the armed force of the Chinese Empire has an establishment of 660,000 men and 930 guns, but of these only 120,000 men of the Lou-kiun are armed with modern rifles and guns. These, together with some police—50,000 in all—and some 50,000 Mongolian Horse, form an efficient force of 170,000 men, to defend a nation of 400 millions. Further, the Mongolian Horse could only be called upon to serve with their own consent, and it is highly improbable that this would be obtained.

If all goes well however, in 1913 this figure will have risen to 400,000, by 1920 to 1,185,000, and by this date the railway system of China will be completed. To attain such a result much money will be required, and the whole of Chinese administration and finance will have to be altered.

It must however be remembered that the changes which have taken place since 1903 are remarkable. The army is now held in esteem, and the numerous military schools are frequented by the sons of mandarins; patriotism and a martial spirit are rapidly developing in the Chinese youth, and the Viceroys—stimulated by the example of Yuan-shi-kai, the organizer of the Northern Army—are following in his lead.

The army no longer consists of an assembly of contingents, each obeying its local Viceroy only, but is a national army under a central government, which has telegraphs and railways at its disposal. It cannot as yet however compare with European armies; desertions are too numerous, discipline is not strict enough, the armament is not uniform, the auxiliary services are hardly created, and the sums given for ammunition are still very small. Nevertheless, the Chinese Army is beginning to be of importance and will increase in value if the War Office continues in its efforts to train officers, and succeeds in putting matters on a firm financial basis.

Military Automobiles in Germany.—A new armoured motor car, which carries a machine gun, six to eight men, and can attain a speed of 60 to 80 kilomètres per hour, has recently been presented by the experimental section of the lines-of-communication troops to General von Lincker, the Inspector-General. If it passes its trials satisfactorily, more such cars will be at once constructed.

The vehicles used by the experimental section of the lines-of-communication troops comprise the following self-propelled vehicles :—

(1). Twenty-five heavy cars with internal combustion engines.

(2). The Siemens Schuckert train of five carriages, the energy being generated by petrol engines on one car and being transmitted electrically to each of the others.

(3). Four steam traction engines. This park can carry 183,000 kilos., and 158 other self-propelled vehicles are subsidized by the Government, and would be capable of carrying loads up to 945,000 kilos.

A. H. Scott.

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RIVISTA DI ARTIGLIERIA E GENIO.

January, 1909.

SERVIA.—*Present Condition of Servian Fortifications.*—*Il Militär Wochenblatt* of the 12th January publishes the following notice by a travelling correspondent of the *Invalido Russo* who has lately made a journey in Bosnia and Servia:—

There are at present four fortified places in Servia—Nisch, Pirot, Saitschar, and Wranja.

Nisch has all the old forms of citadels with seven bastion fronts, now of small importance, besides two groups of old Turkish fortifications (Winik and Goriza) and three forts of modern construction (Ramara, Markow-Kale, and Detljak). It is proposed to reduce Nisch to an entrenched camp. Similar proposals are made with regard to Pirot, which is surrounded by five forts and some redoubts and batteries with very weak profiles, constructed at the time of the war of 1885.

Saitschar is surrounded by three groups, each consisting of three modern forts, constituting a complete entrenched camp.

Wranja was fortified some years ago with 20 works of varied strength.

Between Nisch and Bjela Palanka there is a complete system of works which were constructed or repaired during the war of 1885, and are to-day of little value.

The modern forts are nearly all of the same type; they are of bastion tracing, and consist of two long faces at a very obtuse angle and two short flanks. The profile is of a permanent character, and the forts have many traverses and local casemates, some of which are armoured. Each fort is calculated for a garrison of from 1 to 1½ infantry companies, and for an armament of 12 guns. Latterly a great deal of work has been executed on the fortifications.

FIELD ARTILLERY AND THE LEBEL RIFLE IN THE MOROCCO CAMPAIGN.—The *Internationale Revue über die gesamten Armeen und Flotten* publishes in its pages in October last an article on the action of the various arms used in the fighting in Morocco, from which we extract the following short notices concerning the field artillery and the Lebel rifle:—

According to this notice the fire of the field artillery had not the efficacy that was expected, because the enemy never appeared in masses, but always in a scattered and movable formation against which it was difficult to regulate the fire.

It is also reported that the French fire method (consisting of fire with shrapnel concentrated on a restricted zone, which is supposed to have a moral effect in European warfare) does not produce any impression on these fanatical Mussulmen. The guns of 75 mm. are also shown to be too heavy and of insufficient mobility; an instance is given of an action, against the Mdaras, in which the field artillery did not succeed in following the other troops.

As regards the Lebel rifle, the critics are not satisfied with its ballistic power, and in addition to this both the mechanism of the repeating action and the bayonet are considered not to be entirely satisfactory.

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The repeating action fire was only found useful by the Foreign Legion, who, knowing the enemy's methods, delivered their fire with calmness; this was not the case with the other soldiers, who, firing too rapidly, exhausted their ammunition in a short time, and were not able to have it replaced owing to the difficulty of bringing up reinforcements. The bayonet was also found to be defective, being too long and an impediment on the march, especially when running. The wounds produced by it rarely placed the enemy *hors de combat*, and when meeting any obstacle it was easily bent. It was found, after the action of the 15th May, that almost all the bayonets of a battalion of the 1st Regiment of the Foreign Legion were unserviceable, some being bent almost at right angles.

THE RUSSIAN-JAPANESE CAMPAIGN, 1904.—By D. Luis Fernandez de Cordova, Colonel, Typographic Establishment, De Fortanet, Madrid, 1908.—During the last war in the Far East several foreign missions followed the operations, being attached to one or other of the belligerents. The Spanish Commission, which was attached to the Russian Army, was presided over by Colonel D. Luis Fernandez de Cordova, a distinguished officer who died on return to his country, after being promoted major-general and nominated Aide-de-Camp to the King.

His brothers have now published his reports under the title of "Memoirs." These Memoirs are contained in two volumes with an atlas. One of the volumes is dedicated to the Chief of the General Staff, and is preceded by a biography of the author written by D. Juan Perez de Guzmán, Member of the Royal Academy of History.

In the 21 chapters, into which the book is divided, Colonel Cordova has recorded, in a brilliant style, his journeys, the countries, costumes, and impressions of the regions through which he passed, narrating and commenting on all the actions and important episodes of the Russian Army at which he was present.

His well-considered observations, always interesting, induce one willingly to read the 400 pages of this volume, which concludes with a chapter containing general considerations, with special reflections on each branch of the army.

The other volume contains the author's diary, in which are recorded his impressions of the various military dispositions, and details relating to the mission which he directed. The diary is illustrated with numerous sketches.

February, 1909.

PNEUMATIC ANTENNÆ.—It is frequently, and under many circumstances, found convenient to make use of long antennæ, which have to be of sufficient strength to fulfil the requirements of the work for which they are necessary. Such antennæ may be used for flag or other light signalling, or for other purposes, such as communicating with ships from the shore.

But the difficulty, hitherto found almost insuperable, of combining in one pole or mast the two conditions of length and facility of transport, has limited the employment of such means of communication, and has

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substituted for it other methods—such as the telephone and telegraph—to which it is not always possible to have recourse.

To meet this difficulty, the use of pneumatic antennæ has been suggested, which would combine in one organ the two opposite characteristics referred to above, and which could be most usefully employed for wireless telegraphy in the field.

It is, in fact, well known that the long poles or masts used for the transmission of the hertzian waves, are, owing to their height, very difficult to manage and to transport over undulating ground. These difficulties may easily be overcome with the short pneumatic tubes of which the following is a brief description. The pneumatic pole consists of:—

(1). A tube, or air chamber, of gummed cloth or canvas, closed at the two extremities and perfectly air-tight. This is furnished with a small tube and copper screw, attached at the base to a hand pump which forces the air into the chamber. At the lower end there is a covering of canvas attached to a wooden ring, which is fixed to any convenient basement.

The height and the diameter of the mast may vary according to the purpose for which it is required. Practically it is not convenient for it to exceed 12 mètres in height, which corresponds to an average diameter of 20 centimètres.

Before placing the mast in position the tube is stretched along the ground and is inflated with a pneumatic pump. It is then raised to a vertical position and secured to pegs fixed in the ground.

When the mast is lowered, the air is allowed to escape, and the tube can be rolled up so that it can easily be carried on a man's shoulder, on the saddle, or in a carriage of any kind. The weight of an antennæ or tube, 12 mètres in length, is about 30 kilograms.

AUTOMOBILE FOR CHASING DIRIGIBLE BALLOONS. — The *Rheinische Metallwaren-und Maschinenfabrik* of Düsseldorf has lately constructed a semi-blinded automobile, armed with a quick-firing gun of 50 mms. The carriage is provided with a motor of 60-H.P., and its strength allows it to traverse any difficult ground and to climb slopes up to 22 per cent. According to the Berlin correspondent, the average velocity of this motor would be about 50 kms. an hour, which would be sufficient to follow the course of a dirigible balloon. In exceptional cases it might attain a speed of 70 kms.

The carriage and the wheels are protected on all sides with armoured plates 3 mms. in thickness. The seat for the driver is as usual in front. The gun is placed in the centre and attached to the chassis of the car, and exactly in its centre of gravity. The box for the ammunition is placed behind, and forms a seat for the gunners.

The gun can be pointed, at will, in any direction and at any angle, and is furnished with an hydraulic brake. The supply of ammunition consists of 100 cartridges for shrapnel or for shell. Each shrapnel contains 40 grammes of explosive, 128 bullets of hardened lead of weight 8 grammes, and 27 of 9 grammes.

The weight of this war automobile, ready for the march with gun,

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ammunition, oil, water, etc., and with five men, is 3,000 kgs. The longest range of the gun is about 7,800 mètres, with an elevation of 43°.

Drawings are shown of the automobile and cannon. The French periodical, *la Vie Automobile*, observes that in its estimation it would be difficult, with carriages of this description, to follow over any ground the capricious evolutions of a modern dirigible.

GERMANY.—*Transport Service with Mechanical Traction.*—The following notice is taken from the pages of the *Streffleurs Militärische Zeitschrift* of October, 1908, regarding the mechanical trains organized by the chief engineer, Müller, appointed by the Prussian Minister of War.

One of these convoys, composed of seven carriages with a load of 30,000 kgs., made an experimental journey from the 8th to the 24th July, 1908, travelling 1,600 kms., corresponding to a daily journey of 110 kms.

The same periodical refers to the appointment of 52 retired officers of infantry, field artillery, and motor reservists of the troops of communication, to form a nucleus of a corps of officers of the reserve, for the troops attached to the transport service by mechanical traction. The new organization provides for the detachments which would be constituted in time of war. These detachments would essentially be in depôts or offices for repairs.

It is not proposed to utilize the officers as conductors of the trains. Such officers as have acquired practical experience in the use of transport automobiles of any kind would be employed as required for the technical organization of the mechanical trains, and also in providing for the maintenance of such carriages.

The corps of Motor Volunteers has not any connection with the new institution.

AERIAL NAVIGATION.—From the November number of the *Marine-Rundschau*, the *Rivista Marittima* extracts the following remarks on the navigation of dirigibles :—

In aerial navigation up to the present time the problem of the identification of places has been considered a negligible quantity ; but since the creation of the dirigible, and the possibility of following a route through the air independent of the wind, the study of the art of navigation in the air has become necessary. Aeronautics may be divided into astronomical and terrestrial. For the astronomical department many studies and experiments have been made, which show that owing to the balloon itself being above the observers, there exists a greater possibility of error in the observations and in estimating the altitude. With reference to this it may be mentioned that the Zeppelin airship has an aperture above the car and across the balloon, which is of great assistance for observing the stars. Astronomical navigation is most useful, as dense clouds obscure the view of the earth.

For aerial navigation convenient maps should be designed to show up special points, such as the confluence of rivers, the chimneys of manufactories, railway crossings, places especially illuminated at night, etc., etc. The maps should also indicate the prevailing winds of each locality

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and good points for anchorage sheltered from the wind. Both for convenience, and in order to diminish the weight, the maps may be reduced in size by means of photography.

An International Aeronautical Confederation exists to which Belgium, France, Japan, Italy, Austria, India, Russia, and Spain belong, and a Commission has been nominated by it for the tracing of aeronautical maps, with the following indications:—

(1). For fixing the position at night—lighthouses and beacons; signalling stations; manufactories which keep up continual fires during the night; railway stations; towns; and other places brilliantly illuminated.

(2). Places for a secure anchorage; stations for the production of electricity; marshy lands; places sheltered from the wind.

(3). Indications for the prosecution of the journey and for obtaining assistance; gasometers; places for the preparation of hydrogen; places where a representative of the International Aeronautical Confederation can be found, etc., etc.

Other auxiliaries for aerial navigation are photographs of the districts traversed. The journal quoted above gives some methods for reading such photographs, which at the first glance are somewhat difficult to understand owing to their unusual perspective.

A method, explained by Dr. Elias, but which has not yet been experimented with practically, is also referred to, of showing the velocity and the direction of the wind, and thus rendering aerial navigation possible without a map, when in sight of the earth.

Finally, it is most important that there should be a careful study of the atmospheric conditions and of their changes (wind, temperature, clouds, rain, etc.).

March, 1909.

BULGARIA.—*Orders for Guns.*—The *Militär Wochenblatt*, of the 23rd February, states that the 84 batteries of field artillery ordered in 1906 from the Creusot factories, and also the mountain batteries ordered from the Krupp firm, have all been delivered and distributed to the troops.

Another important order which should be completed before the end of the current year comprises 9 mountain batteries of 4 guns each and 9 batteries of 4 howitzers of 10·5 cm., which are to be supplied from the Creusot works; 34 mitrailleuses, ordered from German factories; and 144 other mitrailleuses, ordered from Russian factories.

Orders have also been issued for the following war material, which has to be delivered in the same space of time:—Ammunition for all the guns existing in the service and for those recently ordered, 200,000 tents, and numerous equipments for pioneers and for sanitary services.

The payment for the material, to be consigned during the year, will be made by an extraordinary allotment of 32 millions of francs, granted by the Sobranje during the last session.

JAPAN.—*Heavy Artillery Gun Practice.*—Reference is made in the journal mentioned above of the 6th March, to the exercises for heavy artillery,

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which are due to take place during the current year near Nagasaki, and which will be commenced towards the middle of May.

The programme will be prepared by the Inspector of Artillery and examined by the Minister. The 5th and 6th Regiments of heavy artillery and the battalions of Nagasaki and of Sasebo will take part in the practice.

Coast Armaments.—In the same journal it is mentioned that, since 1906, works have been constructed both strengthening the existing fortifications and also for new fortifications, of which the following are noted :—Works at Kilau, on the two banks of the passage that leads from the Pacific to the Bay of Osaka; the strong fort of Shimonosaki; the works at Yura, in the island Awaji; the strong fort of Hiroshima, near the military port of Kuro; works at the military ports of Sasebo and Maisuru, and in the Pescadores Islands and at Tsushima. All the forts are armed with guns on the latest system. The construction of the fortress of Keelung, in Formosa, was commenced in 1890 and ended last year. Only the fortifications on the Bay of Tokio are not yet ready, and will require two years more to complete. These, as regards their armaments, will be superior to all the others.

On the completion of these fortifications, the programme of 1896 will have been entirely carried out.

Review of Books and Periodicals.—*Notices on the Austro-Hungarian Army.*—By Lieut.-Colonel Felice Santangelo.—These two books add to the valuable publications which the War School places at the disposal of officers, and by works of a similar kind our great military institute acquires a new title of value in bestowing instruction on the whole of the army.

The two pamphlets meet a requirement, which has been much felt, by answering various questions which have been referred to the War School, since the institution of preparatory courses for senior captains. They naturally have a value, and are of use outside the special purpose for which they are published; and they will be of great advantage, and will be well received by all officers who desire to extend their knowledge in this special branch, viz., the military organization of our neighbours.

The two studies are not in any way exhaustive, and one would not wish that they should be so, and they do not treat of the various special matters relating to the armies to which they refer. They have only the scope of giving a summary idea of what the army is in peace time, and of the condition in which it will probably be found in time of war. The two pamphlets, within fixed limits, are rich in information and data, the materials are arranged in order, and the whole work constitutes a clear and complete record. An index at the beginning of each pamphlet, and numerous quotations in the successive pages, serve as a guide to those seeking for fuller information.

The two pamphlets are not placed on sale to the public, but only to the several commands, and to the officers, who are required to keep the copies which they have obtained, and not to show them to persons unconnected with the army.

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Original Types of Small Houses and Economical Villas.—By Engineer I. Casali. 420 pages with 327 drawings. Price, 5 lire 50 centimes.—In 1906 Lieut.-Colonel Icilio Casali published—by means of the photo-lithographic laboratory of the Minister of War—a valuable *Study of Plans of Small Houses and Economical Villas*, which was reviewed in the pages of this journal in the same year.

The publication—made for the benefit of the sufferers from the Calabrian earthquake and the eruption of Vesuvius—realized by its sale more than 1,000 lire; of this sum, 913 lire was made over, some time ago, to the Minister of the Interior for the use of the military engineers at Rome who had the administration of the said publication; the remaining sum, amounting to more than 100 lire, was given for the benefit of the subscriptions for the disasters in Calabria and Sicily.

The first editions having been completely exhausted, the editor, Hoepli, had the happy idea of republishing the work as one of his well-known collection of manuals. The author has increased the number of plans and drawings, and added many new solutions, the work so constituted forming a rich and varied series of the original work.

Each study in the *first part* represents the solution of a supposed problem, having a series of houses, commencing with modest lodges for small families—designed for a single story—and advancing gradually to houses of two or three stories, with quarters for two or more families in each flat.

With regard to the villas—which constitute the second part—the series is progressive, commencing with modest constructions, which may indifferently be styled villas or small houses, and progressing to edifices of larger size—with proportional increase in the æsthetic and architectural design.

The work is intended to provide for various requirements, and to give designs for a house or a villa of solid and pleasing appearance, which will satisfy the needs of the class of the tenants likely to occupy it. The series concludes with two types of buildings for schools—elementary or professional—in which are shown the relative previsions for educational buildings, and for the gymnastic apparatus belonging to them.

The appendix, which closes the work, contains the rules and regulations which have been issued during the last few years with regard to the construction of buildings, houses, villas, etc.

The intrinsic value of the work, its accuracy and modest price, are a sufficient recommendation for it.

EDWARD T. THACKERAY.

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RECENT PUBLICATIONS OF MILITARY INTEREST.

APRIL, 1909.

(*Published Quarterly*).

THE following extracts from the list compiled by the General Staff, War Office, are published in the *R.E. Journal* by permission of the Army Council.

HISTORICAL.

HISTORY OF CANADA, 1763—1812. By Sir C. P. Lucas, K.C.M.G., C.B. 360 pp., with 8 maps and plans. 8vo. Clarendon Press, Oxford, 1908. 12s. 6d.

This is an interesting publication, and one in which is set forth succinctly the first 50 years of Canada's history as a British possession.

The origin as well as the operations of "Pontiac's War," the Indian war which began in 1763 and continued until 1766, are lucidly stated.

The chapter dealing with the causes of the American War of Independence contains well-reasoned references to colonization, and the relations of the Mother Country to the Colonies. The account of the American War of Independence is a useful addition to the literature, which treats of that unfortunate conflict.

The various treaties and conventions whereby it was sought to demarcate the boundaries of Canada are dealt with in chronological order in an appendix.

THE CAMPAIGN OF 1800 AND THE PART TAKEN IN IT BY THE ARMY OF GRISONS (La campagne de 1800 à l'armée des Grisons). By Lieut. Henri Leplus, Historical Section of the French General Staff. 480 pp., with 9 maps and sketches. Paris, 1908. Chapelot. 8s.

This is a complete and carefully compiled account of a campaign which is not widely studied in England, though it has points of considerable interest.

DUMOURIEZ AND THE DEFENCE OF ENGLAND AGAINST NAPOLEON. By J. H. Rose and A. M. Broadley. 350 pp. 8vo. London, 1908. Lane. 21s.

Beginning with a brief *résumé* of the early life of Dumouriez, this volume follows his career in closer detail after the conclusion of his tour of office as Commandant of Cherbourg (1778—1789). Here he created a great naval arsenal, and devoted much time to schemes for the invasion of England, in which the Isle of Wight figured prominently. He proposed to land in the island 24 battalions, one regiment of dragoons, and eight companies of artillery in shallow draught fishing boats, each carrying 60 men; this force he estimated could embark in two hours, and, by beaching each vessel as it arrived, disembark in the same time. This advanced guard, sailing from Cherbourg, was to be followed by further contingents embarking at Brest, St. Malo, Havre, and Boulogne, bringing the total invading force up to 70,000.

The action of this main body was to depend on circumstances: the first intention was to land in the Southampton Water, mask Portsmouth, and march rapidly on London, with the alternative of landing at Rye, joining the Boulogne contingent there, and thence moving swiftly on the capital.

The absence of the French Fleet at the critical moment was one of the principal reasons why this plan was never given a trial.

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The Revolution gave the Commandant of Cherbourg, then 50 years of age, a wider scope for his energies. In June, 1791, he was given military command of the five Departments at the mouth of the Loire, and in March, 1792, became Foreign Minister, in which capacity he is accused of provoking war with Austria. This position he held only till June of the same year, when he rejoined the army on the Belgian frontier, in a subordinate appointment. Lafayette's downfall in August, 1792, saw the promotion of Dumouriez to supreme command of the Army of the North. A man of wonderful capacity for instilling enthusiasm into his subordinates, he so far inspirited his army of veterans and volunteers, that, after twice breaking in panic, they eventually made a firm stand at Valmy. The advance of the Duke of Brunswick was checked, with remarkable effect on the history of Europe.

The strategy and tactics of Dumouriez at Jemappes in the following November were severely criticized by Jomini: but he defeated the Austrians, and the effects were again far-reaching.

Defeated at Neerwinden in March, 1793, his enemies in Paris gained the upper hand, and sent Commissioners to him at St. Amand to depose him from his command. He refused to accept the decision, and arrested the bearers of the message; but after he had entered into negociations with the Austrians, his army deserted him and he fled, eventually finding an asylum in England.

Here he offered his services to the War Office, and appears to have been for some time in receipt of pay from the British Government. His intimate knowledge of the French Army, and his previous study of the question of invading England, made his advice on the subject of a Defence scheme of the greatest value: while his hatred for Bonaparte acted as a spur to his efforts.

His detailed scheme for the defence of our coast is given in full, and is of great interest.

He anticipated having to deal with about 50,000 hostile troops, and to meet them he proposed to divide England into six military districts, and the 600,000 men then available in England into divisions of about 12,000 each: some to be stationary, to oppose landings, others to be mobile and to be ready to concentrate rapidly at threatened points. He draws particular attention to the dangers of a purely passive defence.

The maps are good, but a plan of the Battle of Valmy on a larger scale than the one provided would have been an improvement.

THE LIFE OF JOACHIM MURAT (1767—1815). Vol. I. (Joachim Murat (1767—1815)). By Prince Murat, with an introduction and notes by Paul Le Brethon. 550 pp., with portrait and facsimiles. 8vo. Paris, 1908. Plon-Nourrit. 6s.

This work is of considerable interest, as it contains a number of documents and family papers which throw a clear light upon the career of the unfortunate King of Naples, and upon the campaigns in which he took part. The first volume deals with the early portion of Murat's career, up to 1801, and more especially with the campaigns in Italy and in Egypt.

ENGLISH AND FRENCH (Anglais et Français). By General Zurlinden. 152 pp. 8vo. Paris, 1908. Lavauzelle. 2s. 8d.

The author of this book is the famous French ex-War Minister. In the first part of the book he points out that, although England and France have been constantly at war in the past, the time seems to be now not far off when they may be fighting side by side as in the Crimea. The writer has therefore thought it would be of interest if he gave his countrymen some idea of the special qualities which the British race has displayed in past wars. For this purpose he has made a special study of the Histories of England written by Hume and Lingard, and he places the result of his labours before his readers. In the second part of the book General Zurlinden deals with the Battle of Fontenoy, upon which he professes to throw fresh light. In the third part the writer discusses the Battles of Ligny and Waterloo, and explains what he thinks were the causes of the French disasters in 1815.

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INFLUENCE OF FORTRESSES IN MILITARY OPERATIONS; THEIR ADVANTAGES AND DISADVANTAGES, AS ILLUSTRATED BY THE EXAMPLE OF THE VENETIAN QUADRILATERAL (Schädlicher und nützlicher Einfluss der Festungen auf die Kriegführung). By P. Rath (Captain, Austro-Hungarian General Staft). 316 pp., with 4 maps. 8vo. Vienna, 1909. Seidel. 6s.

This work deals with the many campaigns centring round the Venetian fortresses, from the time of Napoleon, 1796, up to the modern events of 1865, when Venetia was finally wrested from Austria.

Apart from opinions as to the value of fortresses on a campaign generally, the actual fate of the various fortresses of the Quadrilateral is interesting. To take the case of Mantua, for example, this place changed hands five times, while the statistics show remarkable variations in garrisons, investing force, and relative proportion of one to the other.

THE LIFE OF HENRY PELHAM, FIFTH DUKE OF NEWCASTLE, 1811—1864. By J. Martineau. 334 pp., with index. 8vo. London, 1908. Murray. 12s.

This book contains an interesting and careful biographical study of the Duke of Newcastle, who held the important offices of Secretary of State for War in Lord Aberdeen's Coalition Government of 1852 and Colonial Secretary in Lord Palmerston's Administration of 1859.

From a military point of view the greatest interest centres in the correspondence which passed whilst he held the former office and was responsible for the preparation for, and conduct of the Crimean Expedition. It is clear that this War was due to popular clamour and not to any political necessity, but it is equally evident that the Government was as ignorant of the state of the Army as they were ill-informed of the theatre of war, defences, and strength of the enemy. The advance into the Crimea was determined on in opposition to the judgment of both the English and French Generals and Admirals who were on the spot and whose military and naval experience was allowed to count for nothing.

In the famous despatch of the 29th June, 1854, urging the advance upon Sebastopol, the Duke only acted as spokesman for the Cabinet, but for the subsequent communications to Lord Raglan he is solely responsible, and it is evident that he failed to realize the great difficulties of the situation in which the latter was placed. The Commander-in-Chief was inundated with letters of advice and warning, even on small matters of detail, which must have seriously handicapped him in attending to the more serious matters which urgently demanded his closest consideration.

Too late it was realized by the responsible Minister that the expedition, despatched more or less as a flying column, and equipped as such, was in reality a serious undertaking, demanding the resources of a well-equipped army, supplied with all the necessaries for a long winter campaign and the siege of a formidable fortress.

That the result of the expedition was not as disastrous as it might have been was due to the endurance and pluck of the Army in the field, and not to the foresight of those responsible for the hardships to which it was subjected.

As Colonial Secretary the Duke of Newcastle appears to have profited by the experience of the Crimean War. During the war in New Zealand in 1861 he writes to Colonel Gore Browne, the Governor:—

"Each succeeding mail from New Zealand has more and more convinced me of the danger of laying down at this distance any precise instructions, either for your guidance or that of the military authorities. . . . I should be running a great risk of complicating the already serious difficulties of the Colony if I attempted to regulate affairs by didactic despatches which require more than two months for their transmission."

Mr. Martineau adds:—

"Would that the same temper had oftener been displayed by other chiefs in letters from the Colonial Office."

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THE PANMURE PAPERS. Edited by Sir J. Douglas, Bart., and Sir G. D. Ramsay, C.B. Vol. I., 515 pp.; Vol. II., 533 pp. 8vo. London, 1908. Hodder & Stoughton. 24s.

The large selection of letters which have here been brought together deal mainly with the later stages of the Crimean War, during which Lord Panmure held the office of Secretary of State for War in Lord Palmerston's Ministry formed in February, 1855.

The moment at which Lord Panmure was summoned to the administration of the War Department was one of great national stress. The Army of the Crimea had reached the lowest depths of misery, and that Lord Panmure fully realized the cause of this may be seen in a paper written by him shortly after taking office, in which he says:—

"Our Army is a mere aggregate of battalions, . . . The regimental system is as nearly perfect as it can be. The system by which an army should be provisioned, moved, brought to act in the field and in the trenches, taught to attack or defend, is non-existent. All that was done in the Peninsula by the Duke of Wellington was frittered away and lost by a false economy forced upon us by successive Governments, and which we never have had the courage to resist.

Having noticed the defects in the Army system then in force, he at once set about establishing a better order of things in the Crimea and devoted special attention to matters vitally concerning the efficiency of an army in the field—"land transport, scavenging, sanitation, commissariat and the medical department."

The result was that the second winter spent on the heights of Sebastopol was very different from the first, and the army passed to a condition of efficiency both in camp and in the field. From the correspondence which took place between the Secretary of State for War and the British Officers who successively commanded the Expedition, it will be seen that too much credence was given by the former to camp gossip and idle rumours, with the result that the latter, although already heavily burdened with responsibilities, and surrounded with troubles due to the short-sightedness of the Government and to no fault of his own, was still further hindered in his onerous task. The editors of these papers point out that the letters now made public modify considerably the view which Kinglake took of the relations between Lord Panmure and Lord Raglan, but it appears that the practice of softening the harsh tone of the official communications by private letters of a friendly description was not satisfactory and did not entirely remove the impression that the Government was dissatisfied with him.

Nevertheless, Lord Panmure may justly be said to be one of the first who helped to reform the British Army in accordance with the requirements of modern warfare, and the impression conveyed of him is that of an exceptionally able administrator. To anyone who wants to know the inner history, diplomatic and military, of the Crimean War this publication will prove of the greatest value, as also to the student of the evolution of the British Army. It was under Lord Panmure's administration that the Office of Chief of the Staff was originated.

These papers should be read in conjunction with "Life of the Duke of Newcastle."

THE INDIAN MUTINY, 1857. A Sketch of the Principal Military Events. By Capt. F. R. Sedgwick, R.F.A. 160 pp., with 5 maps and 4 appendices. 8vo. London, 1909. Forster & Groom. 5s.

This book has been written to meet the want of military students of a concise account of the purely military events in India in 1857-58. It shows much more clearly than do fuller histories of the Mutiny the connection between the different series of operations, and the use made of the widely divergent bases of operations in the North-West, East, and South for concentration upon the area of revolt.

The accounts of many actions won against overwhelming numbers teach the effect of audacious leading against Asiatics, and show how possible and necessary it may be in such warfare to act in defiance of generally accepted rules.

The book opens with an Introduction on the subject of Small Wars, and closes with a brief consideration of the effect which the existence of the present system of railways in India might have had upon the progress of the campaign.

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FRONTIER DETACHMENTS (Grenz-Detachements). By General v. Verdy du Vernois. 393 pp., with maps. 8vo. Berlin, 1908. Mittler. 8s. 6d.

This is a reprint, under a new title, of the first part of the author's "Studien über den Krieg" (Studies of War), which was published in 1892. It deals with the situation and events near the frontier during the early stages of the war of 1870–71. The general situation is first passed under review, and the tasks devolving on the various detachments near the frontier are then discussed.

THE LEADERS OF THE GERMAN ARMIES IN 1870 (Le haut commandement des armées allemandes en 1870). By Lieut.-Colonel Rousset, former Professor at the French Staff College. 340 pp., with a map. 8vo. Paris, 1908. Plon-Nourrit. 3s.

The author of this book is well known in English military circles, as he gave a lecture in London last June in connection with the organization of artillery for the Territorial Army.

In publishing this volume, Colonel Rousset has endeavoured to show that the German victories in 1870 were principally due to good fortune, and were not gained by any great strategical skill or tactical superiority. He certainly succeeds in exposing grave dissensions among the Prussian leaders and serious errors in the conduct of the campaign, but he does not appear to have made sufficient allowance for Moltke's difficulties nor for the fact that many apparent mistakes were committed deliberately, as a result of the evident incapacity of certain French generals.

At the same time, Colonel Rousset has made it quite clear that the Germans owed a great deal to good fortune, and that the mistakes made by the French leaders were quite extraordinary, and are most unlikely to be repeated. He has performed excellent service for his country by showing that there is no cause for Frenchmen to despair of the result of a future war, provided that a true military spirit be kept alive in France.

The book draws practically all its material from German sources, and many of the extracts and quotations are of great interest, especially the appendix dealing at considerable length with the memoirs of Prince Kraft von Hohenlohe-Ingelfingen. The importance of these memoirs has been overshadowed by those of the Prussian Chancellor, Prince Hohenlohe, but they are nevertheless of great value, as they give a clear insight into the methods adopted by Germany in preparing for war, and into the thoroughness of her preparations.

Colonel Rousset's work is most interesting, and can be recommended to all students of military history, and more especially of the Franco-German War of 1870–71.

THE RUSSO-JAPANESE WAR, 1904. By Capt. F. R. Sedgwick, R.F.A. 192 pp., with 12 maps. London, 1909. Swan, Sonnenschein & Co. 5s.

This book belongs to the *Special Campaign Series* and covers the same period as the two parts already issued of the *Official History of the Russo-Japanese War*, but in value cannot be compared to the latter.

INFLUENCE OF THE EXPERIENCE OF THE SIEGE OF PORT ARTHUR UPON THE CONSTRUCTION OF MODERN FORTRESSES. By A. von Schwartz. Translated by the General Staff, U.S.A. 178 pp. Royal 8vo. Washington, 1908.

The author, a lieutenant-colonel in the Russian Engineers, was responsible during the siege for a considerable section of the defences on the north-east front, so that his comments may be taken as those of an eye-witness with a professional knowledge of his subject.

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Chapter I. deals with the main features of modern land fortresses, and points out some peculiarities of the German and French systems as compared with the Russian.

Chapter II. describes the plan of the fortress of Port Arthur under three headings, viz :—(1), The original plan ; (2), modifications and alterations before the war ; and (3), the condition of the fortress during mobilization and throughout the siege.

The defensive works, according to the original plan, were to consist of a row of coast batteries, a line of land fortifications on the advanced heights (divided into the north-east, north and west fronts), and a central enceinte surrounding the old city.

The armament was to consist of 541 guns and 40 machine guns. The west front was considered the weakest, owing to want of mutual support and the proximity of commanding heights at short range from the north-west.

In 1899 Colonel Velichko worked out a revised plan for the defence of Port Arthur, which was rational enough, but which, owing to various unforeseen circumstances, was not carried out in its entirety before the outbreak of the war.

Chapter III. describes the condition of the fortress at the beginning of the investment, and the strength and armament of the opposing forces. The outbreak of hostilities found the defences in a state of unpreparedness, which necessitated hasty additions during mobilization. The "work was done with feverish haste and with no semblance of order, and the quality suffered in consequence."

The chaos which existed at Port Arthur on the outbreak of the war was due to the absence of a preconceived plan of action in the event of a sudden mobilization.

Some of the most glaring of the defects were the weakness of the defences of the Ta-ku-shan and Hsiao-ku-shan Hills, the insufficient distance ($\frac{3}{4}$ to $2\frac{1}{2}$ miles) of the forts from the centre of the city, the exposed positions of the interior communications, absence of field-railways, balloons, underground telephones, observation stations, etc., etc.

Chapter IV. quotes incidents in the siege to prove the importance of advanced positions and constant observation of the intervals between forts and the necessity for covering such intervals with rifle fire.

Chapter V. discusses the question of the length of the intervals between forts. In the author's opinion these intervals should not exceed $1\frac{1}{3}$ miles, in order to ensure adequate mutual support from rifle fire.

In Chapter VI. the author emphasizes the need for field-railways in the interior of fortresses to facilitate the transport of ammunition and engineer material.

In Port Arthur, during mobilization, 12,000,000 lbs. of engineer material had to be carried along a line of defence 12 miles in length. There were no railways, and the roads, by which the carts moved, were exposed to the enemy's fire.

Search lights played but a secondary part in the defence of Port Arthur, owing to the insufficient number available and the lack of practice in using them. The siege, however, demonstrated their great importance.

Chapter VII. gives the strength of the garrison of Port Arthur as originally intended and as it was during the siege.

The garrison was originally fixed at 11,300 men, or 1,130 men per mile of perimeter.

When the investment began, the garrison numbered 41,016 men, of which 34,503 were combatants fit for duty, 4,189 non-combatants, and 2,324 sick in hospital.

Including the naval brigade and citizen companies, the total force amounted to about 50,000 men.

Chapter VIII. deals with details of the construction of modern fortresses.

In Chapter IX. the author suggests a plan for a fortress based on the lessons to be learnt from the Siege of Port Arthur.

Chapter X. concludes with the statement that the Siege of Port Arthur "showed decisively that the fate of a modern fortress is decided on the line of forts."

Good maps and diagrams are attached.

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POLITICAL.

THE RIVALRY OF RUSSIA AND ENGLAND IN CENTRAL ASIA. By M. Grulev. 380 pp., with 3 maps (1 coloured). 8vo. St. Petersburg, 1909. V. Berezovski. 6s. 3d.

The author served for 14 years on the General Staff in Central Asia and the Far East.

The professed object of this book is to educate Russian public opinion to some grasp of the danger of a forward policy in Central Asia. That expert opinion has undergone a change as a result of the disastrous outcome of the policy of adventure in the Far East is proved by a quotation from Kuropatkin's book on the recent war. The originator of the Kushk Branch and the founder of the Termez Post is now of opinion that "the recent sacrifices and risks in the Far East should make Russians pause to think, when led away by dreams of an outlet on the Indian Ocean, an attempt to gain which would lead to a war with Great Britain even more useless and horrible than the late war with Japan."

The first seven chapters are devoted to a statement of the problems in Central Asia from the point of view of a Russian staff officer. In the last two chapters an appeal is made to the Russian Government to abandon its traditional policy and to content itself with the development of the resources of Russian Central Asia, where Ferghana, the greatest cotton-producing district of the Empire, is without roads, while money has been squandered on works of purely strategic object like the Kushk Branch.

It is a matter for regret, in view of the laudable object of the book, that the author in these last chapters has not fairly stated and faced the main problem. He contents himself by proving by means of copious extracts from an English writer that the Indian Empire cannot be conquered by an expeditionary force equipped with pack transport.

The first chapters contain much of interest.

The author is of opinion that while owing to transport difficulties the main effort against India can never be directed through the Pamirs, still in case of war a diversion should be made on this line by a force of the strength of a brigade of rifles with mountain artillery to cause the British to detach from their main front. He bases this opinion on the supposed direct connection between the first occupation of the Pamirs by Russia and the general revolt of the frontier tribes in 1897.

A gloomy picture is drawn of the State of Bokhara. Russian protection, limited by the policy of non-interference in civil administration, has proved an unmitigated evil. During the 36 years the Protectorate has lasted, the condition of the country has grown steadily worse The people are powerless to rebel against the over-taxation of a government which is supported by the Russian garrisons at Charjui, Kerki, and Termez. Meanwhile the revenue is wasted by the Amir in maintaining a useless army, and squandered by the district officials in large studs of Arab horses and enormous harems.

The author thinks that a Russian railway through Persia to the Gulf would only be of value to Russia if she had command of the sea. Under present conditions it would be a convenience merely for British trade. He advocates the continuation of the line from Julfa by Tabriz, Teheran, and Meshed to Kushk. It is stated that the miserable conditions now ruling in Persia cause the long-suffering people to pray for Russian intervention. "In a stroll through the bazaars of Teheran, the continual cry of the people is heard:—'O Allah, when will there be an end to all this? When will the Russians come?' And the cry grows daily louder and more persistent." The author is unable to believe that the present policy of co-operation in Persia can last long, though the "two European powers now seem to be impartial spectators imbued with mutual *official* trust" It will be news to English readers that some of the employees of the Indo-European Telegraph Company in Persia are officers of the Indian Army.

Similarly the information regarding India is often inaccurate. We read that the Indian Government quarrelled with the Maharajah of Kashmir in 1895 and took over the government of the country. The *Civil and Military Gazette* is quoted as "the recognized official organ of the Commander-in-Chief in India."

With regard to our military policy towards the frontier tribes the writer says: "The more these tribes fight with the English the keener does their taste for rebellion become. They willingly take up arms once more and use their experience to foment disaffection among tribes less experienced and less decided in character."

The map of Central Asia is clear but inaccurate.

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NAVAL.

GERMANY'S FLEET IN BATTLE (Deutschland's Flotte im Kampf). By Capt. Graf Bernstorff, German Imperial Navy. 208 pp. 8vo. Minden and Leipzig, 1909. Wilhelm Kohler. 3s.

The writer conceives a war between Germany and Great Britain, brought about by the Government of the latter country presenting an ultimatum demanding that Germany should abandon her position in the *tri plice* and offering in return certain guarantees as regards the North Sea and Baltic littorals and the integrity of the German Protectorates.

The German Government answers by declaring war, which declaration is preceded by the despatch of mine ships to the English Channel and a submarine to the Straits of Gibraltar. Much damage is done to British war shipping by these means, and in the great naval battle which takes place off Heligoland between the two belligerents, the British Navy is defeated, and the remnants seek shelter in British ports, pursued by the crippled German fleet. An allied Power to Great Britain, presumably France, interposes her fleet between the flying British ships and their pursuers, and so prevents the utter downfall of Great Britain.

The story is graphically told and written by an officer on the active list of the German Imperial Navy; it is possible that his ideas regarding the extensive use of mines and submarines in war reflect those of the German naval authorities on the subject.

STRATEGICAL AND TACTICAL.

MODERN WAR (Der Krieg in der Gegenwart). Unsigned article from the *Deutsche Revue*. January, 1909.

This article, popularly attributed to Field Marshal Count Schlieffen, created some sensation owing to the German Emperor's reference to it in his New Year's speech.

A translation of the article appears in the February number of the *National Review*, and is divided into two portions; the first tactical, the second political.

The following is a summary of the first portion.

The Peace of Frankfort put an end to the struggle between Germany and France in appearance only.

One of the two opponents invented improved weapons, but could be sure that the other would before long discover still more perfect ones. The only endeavour has been to obtain, for the impending war of revenge, some advantage over the outwitted enemy by means of a superior weapon. In the course of years there have been moments when one of the two opponents thought to have attained his object, when it only remained to him to utilize the favourable moment. There were, however, other considerations, and owing to hesitation the enemy was allowed to make good the lost ground. The other powers have not been able to remain indifferent spectators of this competition, but it has been enough for them to profit by the experience and outlay of the others. Not only in Europe, but also in the Far East and West the Franco-German quarrel has resulted in most armies being equipped with arms of great efficiency and of almost equal value.

The author describes the murderous effect of modern firearms, and points to losses of 68 per cent. in France and 90 per cent. in Manchuria. The technique of arms has had great triumphs, but the object of all the Powers, namely, a diminution of the difficulties of war and superiority over the enemy, has not been attained—on the contrary greater difficulties and more serious drawbacks have been produced. It is easy enough to say how the foe is to be swept down, but how to escape annihilation one's self is not easy to determine. A complete change has become necessary in tactics, for those of Frederick and Napoleon would lead to the troops being swept off the face of the earth. It is not even possible to overpower the enemy by dense lines of skirmishers. It is only by the use of the cover afforded by trees, walls, houses, and ditches, by elevations and depressions, that the infantry soldier can get near his foe. Lying, kneeling, and standing alternately he must, without exposing himself, endeavour to hit the small target presented;

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he must beat down the hostile fire with his own, then quickly take some new cover and commence the struggle anew. But whatever cover the terrain may offer, sooner or later he will be separated from the enemy by an open space; if this be narrow the assailant may dash across it, but if it be broad he must seek cover with the help of his spade and advance from one line of trenches to another, and, if necessary, by night.

It is the business of the artillery to help the advance of the infantry and to destroy the enemy and his cover, and as it is not so easy to hide guns as men, an attempt has been made to protect the former with shields.

In order to get sufficient cover to fire in security and to advance rapidly, the infantry soldier requires elbow-room, and he can only fight effectively in thin lines with not more than one man to the mètre. Other lines follow at some distance and draw together when cover permits of it. They are needed to replace losses and to meet unforeseen occurrences. It is only for the final attack that the reserves which have followed steadily in rear come up to the thin front line. Thus a direct result of the improvement in firearms is a great extension of fronts. Up to 40 years ago 10 men per pace was considered normal, while in the war in East Asia in 1904-5 it was usual to allot three men per mètre, or even less at a pinch. Neither of the opponents had any preconceived theory—these extended fronts were brought about by force of circumstances, and there is little doubt that the same thing would occur in a European war. Armies of the strength of those which fought at Sadowa and Gravelotte will take more than four times as much room.

Universal service was 40 years ago the speciality of Prussia, and no other State envied this narrow-minded military power; since 1866 and 1870 nearly all Powers have hastened to appropriate this secret of victory, and every healthy youth is sent to the colours. Germany and France have respectively 4,750,000 and 5,500,000 men. These numbers are, however, more or less imaginary, and the author depicts at length the inefficiency of the reservist suddenly drawn from private life. The numbers would not be united in a single fight, and the writer describes with some detail how little will be visible to the participant in a modern battle, and how the modern general will command in a roomy house surrounded by telegraphs and other signalling apparatus, with motor vehicles of all kinds at his disposal. He describes the course of a battle and the arrival of reports of the increasing strength of the enemy, coupled with demands for reinforcements, which the general will not be able to send, not only on account of the distance they would have to go, but on account of the lack of room in the firing line.

"The essential task of the leader is fulfilled when, long before the encounter is possible, he has pointed out to all armies and corps the lines of their advance and the points they are expected to reach day by day. The assembling for the combat commences when the men leave the railway.

"As the frontage is greater than formerly the troops will be able to march on fronts at least as great as those which they will occupy in the battle, and the concentration for the battle has lost a good deal of its former importance. Those corps which get into touch with the enemy will not be able to count on being supported. With 144 excellent guns and 25,000 excellent rifles each corps will be able to do at least 10 times as much as in the days of the muzzle loader. If a corps nowadays takes up a front three times as great as 40 years ago it is not splitting up its forces, but increasing its strength. With such a front it is well able to attack, to hold what it gains, to meet losses of 50 per cent. and yet to keep a reserve in hand for the final assault on the hostile position. Not, however, that it will be an easy task to advance from cover to cover, to creep up to the enemy's position, to persevere by night and by day, and to be ready at all times to repel a counter-attack."

All armies will not take part in the battle on the first day, and the battle of the future will last for several days, on each of which the commander will demand new sacrifices from those already taking part in it. The author refers to Leipzig, Le Mans, Orleans, and Mukden. "These long-drawn fights will be less bloody than those in the past; thus those in the Manchurian Campaign cost only 2 or 3 per cent. compared to the 40 and 50 per cent. of the days of Frederick and Napoleon, and the 14 days at Mukden cost the Russians and Japanese less than a few hours at Mars la Tour did the French and Germans.

"The Russo-Japanese War has proved that in spite of all difficulties a mere frontal attack may succeed, but its results will be only small, and the enemy, though he may

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withdraw, will soon offer fresh resistance—and so the war drags on. Wars of this kind are, however, impossible at a time when the existence of a nation is dependent on the uninterrupted continuation of commerce and industry, and when a rapid decision is imperative in order to permit of trade machinery being again set in motion. Strategy based on wearing out the enemy is out of the question when the existence of millions of men means the expenditure of milliards. To obtain a decisive and annihilating result the front and one or both of the flanks must be attacked, and this is comparatively easy to carry out if one side is much stronger than the other. This marked superiority cannot now be always counted on, and in order to get the numbers for a strong flank attack, those opposed to the front must be reduced as much as possible, but never so much that they can only hold the enemy—it is imperative that the front be attacked. The quick-firing, long-ranging rifle is specially adapted for this purpose, provided the necessary ammunition be forthcoming, and it is better to have ample reserves of ammunition than reserves of men. Cartridges following the army in power-traction vehicles form the best and most reliable reserve, and the troops which formerly were kept in reserve in order to give the decisive stroke must now be moved to the attack of the flank from the very commencement. The stronger the troops available for this purpose the more decisive will it be."

The author lays stress on the importance of previous knowledge of the position of the flank, and describes how this reconnaissance—once the work of the cavalry—will in future be carried out by dirigibles and aeroplanes.

"The cavalry will now be free to bring the fire of its long-range carbines, its Maxims, and its artillery to bear on the rear of the enemy. It will have, however, to meet the hostile cavalry as before, ere it can carry out this duty; thus in the future, as in the past, artillery will have to fight artillery, cavalry cavalry (and balloons balloons), before they can in combination assist the infantry to win the final victory."

THE FRONTIERS OF FRANCE. 1ST VOLUME (Frontières Françaises. Tome premier). By Gustave Voulquin. 102 pp., with 14 maps and 14 engravings. 8vo. Paris, 1908. Bibliothèque Larousse. 1s.

This is the first of three volumes which are to deal with the defences of the French frontiers, and also those of the naval ports of France, Algeria, and Tunisia.

There is a preface by that distinguished member of the French Chamber of Deputies, Monsieur Pierre Baudin, in which it is explained that, at the present day, it is absolutely necessary that every Frenchman should have a general knowledge of the defences of his country, and at the same time should understand that no amount of fortification can render a country secure against attack, but, on the contrary, that the only true use of fortifications is as pivots of manœuvre for the Field Armies. It is with the object of enlightening the French "man in the street" on these points that this series of books is written. The present volume is divided into four parts. The first deals with the defences of the first line on the Northern Frontier, and the second part is concerned with similar defences on the Eastern Frontier, whilst in the third part a general description is given of the second line defences of these two frontiers, and the fourth part is devoted to an account of the Paris entrenched camp. The arrangement of each part is the same. First, the general configuration of the ground in each area is described, then the natural defences, and, finally, the artificial defences.

The volume is, of course, written on very general lines, but should answer its purpose well. The maps in the book are clear, and considerably elucidate the reading of the book.

ILLUSTRATIONS OF TACTICAL DETAILS FROM THE RUSSO-JAPANESE WAR (Taktische Detaildarstellungen aus dem Russisch-japanischen Kriege). Supplement to "Streffleur's Militärische Zeitschrift"—Part I. By Colonel . Habermann and Capt. Nowak, working under the (Austrian) Chief of

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the General Staff. 59 pp., with plans and landscape sketch in text, 6 appendices, maps, and photographs. 8vo. Vienna. Seidel. 1s. 8d.

It is explained in a preface to this work, that whereas the monographs on the Russo-Japanese War furnish a general outline of the campaign and are primarily intended for the study of higher leading, the detailed illustrations supply a want much felt by regimental and departmental officers.

The first portion of the book deals with the night attack of the Russians on the Motienling Pass on July 4th, 1904. The description of this operation is admirably clear, and is supplemented by excellent maps and sketches. A criticism follows.

The second portion is devoted to a description of the fighting around Mukden, taken from the diary of the Austrian Capt. Franz, who was attached to the 5th Japanese Division. Capt. Franz witnessed several infantry attacks from a position immediately in rear of the advancing Japanese troops, and gives a most realistic account of what he saw. The narrative is supplemented by some excellent photographs, with a note at the bottom of each to the page in the text which refers to the illustration.

Capt. Franz mentions the small effect of artillery fire and the fact that several Japanese soldiers were killed by grenades which they were carrying.

Officers who can read German will find this book of great assistance in bringing home to those under them some lessons of the most recent great war.

TRAINING AND EDUCATION.

Tactical Problems for Manœuvres and War Games (Taktische Aufgaben für Übungen und Kriegsspiel). By Major Immanuel. 3rd edition, re-written throughout. 431 pp., with 4 maps and 2 sketch maps in pocket. 8vo. Berlin, 1909. Mittler. 10s.

In this edition the number of problems has been reduced from 225 to 110, and a complete solution of each problem is given. The first 144 pages are devoted to the statement of the problems, the following 287 pages to their solution. The problems are practical and instructive, and the solutions are not merely dry answers, but lucidly reasoned appreciations. The detail given in the answers is throughout in accordance with the latest German official publications. The problems are divided into sections dealing with the following subjects:—Combats; entrenched positions; marches, reconnaissance, and screening; cessation of operations; outposts, quarters, and supply; minor operations; and guarding a frontier. Each section contains problems in which forces of different strength are employed. Except in the section concerned with minor operations, the forces range from a small mixed force (battalion, battery, and squadron) to an army corps.

Ten of the 61 problems in the first section refer to the battle of encounter. In most cases the problem is in duplicate, that is, it has to be solved by both the opposing commanders. Numerous cavalry problems are given, but the artillery are not separately considered. The four large maps which accompany the book are on a scale of about 1½ miles to the inch, and represent districts on the Franco-German and Russo-German frontiers.

The Science of Writing Orders in the Higher Command Staffs (Die Befehlstechnik bei den höheren Kommandobehörden). 2nd edition. Anonymous. 92 pp. 8vo. Oldenburg. Gerhard Stalling. 2s.

This exceedingly useful book on the writing of orders has been written for the use of candidates presenting themselves for examination for the Staff College, and for use in working out tactical schemes, during tactical tours, staff rides, and war games.

Some useful hints are given as how to solve tactical schemes, to write an appreciation, and to draw up orders.

Examples of orders issued by army, army corps, divisional, and cavalry divisional commanders for various situations are given in detail.

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FORTIFICATION AND MILITARY ENGINEERING.

A STUDY OF THE RÔLE OF ENGINEERS IN THE FIELD (Étude sur le rôle du génie en campagne). By Lieut.-Colonel Klein. 238 pp., with 6 plates. Paris, 1908. Berger-Levrault. 4s. 4d.

The author of this book disclaims any intention of advocating the use of the defensive. On the contrary he declares that his object in writing is to show how the engineer can help his General by enabling him to occupy a considerable tract of country with a small force, thereby leaving more men available for the offensive. To illustrate his meaning the author takes the first three weeks of the Franco-German War of 1870-71 and, with the object of showing how different things might have been if intelligent use had been made of fortification, describes in detail the general situation of the opposing forces at the commencement of hostilities, the Battle of Weissembourg, the concentration of the French Army, and the Battle of Woerth. The last three chapters of the book are devoted to notes on the establishment of pivots of manœuvre, the preparation of the battlefield, and the utilization of the resources of the engineers.

The writer comes to the conclusion that, in order to enable the engineers to carry out their *rôle* properly on the battlefield, it is necessary to have (*a*) an officer in command of the engineers who can at once make up his mind how best to assist in carrying out the plans of the Commander-in-Chief; (*b*), an Engineer Staff who can recognize what engineer works are necessary to meet any tactical situation; and (*c*), a specially selected engineer *personnel*.

AERIAL NAVIGATION.

AERIAL WARFARE. By R. P. Hearne. 231 pp. 8vo. London, 1909. T. Lane. 7s. 6d.

This volume contains a detailed description of all forms of aerial navigation from its inception up to the present time, and gives recorded performances of dirigible balloons and aeroplanes. The author considers that the strides that have been made in aerial navigation during the last few years are so great that it is only reasonable to expect an extraordinary development within the near future. He maintains that the actual use of airships in war, even in their present state, would be very great, and that shortly a first-class power, wherever it may be situated, will not be able to do without them.

When a satisfactory pattern of airship has been designed the construction of a fleet of them will not be a costly or lengthy proceeding, but, the author holds, that unless a staff with practical experience in building and operating vessels is available, it will be impossible to construct anything of the sort at short notice.

Mr. Hearne discusses in detail the uses to which airships are likely to be put when introduced into practical warfare, and the damage which a small fleet could do with comparatively little risk. He concludes with a strong appeal for the formation of an Aerial Defence League, for which he thinks the time has now come. In the introduction Sir Hiram Maxim gives it as his opinion that eventually airships will stand a very poor chance against aeroplanes, but he fully agrees with the author in considering that flying machines have come to stay and "that measures should be taken to put us abreast with other nations."

The volume has numerous excellent photographs of the various types of vessels and is well worth study, though possibly from a military point it might with advantage have been somewhat curtailed.

INSTRUCTIONS FOR THE SERVICE OF MILITARY AEROSTATICS (Instruction pratique sur le service des Aerostats Militaires). Official. Three vols. of 90, 140, and 132 pp. respectively. 8vo. Paris, 1908. Lavauzelle. 6s. 6d.

These are the latest instructions on Aerostatics issued to the French Army. They are in three volumes and deal in great detail with all matters connected with military

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ballooning, exclusive of dirigibles and aeroplanes. The first volume deals with the general principles of aerostatics and gives descriptions of all material. The second and third volumes contain chapters on—

"Manipulations de détail."
"Manœuvres sans gonflement."
"Gonflements."
"Manœuvres avec ballon gonflé.
"Transports de ballon gonflé"; and
"Ascensions Libres."

ORGANIZATION AND ADMINISTRATION.

THE GERMAN ARMY IN 1910 AND THE FRENCH ARMY AFTER THE RECENT CHANGES (L'armée allemande en 1910 et l'armée française d'après le projet du loi des cadres). By Capt. F. Culmann. 84 pp. 8vo. Paris, 1908. Berger-Levrault. 2s. 1d.

The author compares the number of the different units of both armies, and notices particularly the numerical superiority of the Germans in cavalry and artillery.

He then sketches the principles of French and German organization, and the changes resulting from the new law regulating military establishments in France.

Comparison is made of the number of infantry battalions existing at different periods in France and Germany, and the steady continuity of German policy is contrasted with the constant changes in France.

Separate chapters deal in detail with the comparison of French and German infantry, cavalry, artillery, and the question of machine guns and pom-poms is then discussed.

BOOKS OF REFERENCE.

MAPS OF EUROPEAN COUNTRIES USEFUL FOR MILITARY PURPOSES (Die militärisch wichtigsten Kartenwerke der Europäischen Staaten). Extracted from "Mitteilungen des Militärgeographischen Institutes." 238 pp., with 11 plates.

This is a useful summary of the principal maps in use in the various countries of Europe. The title of the map is followed in each case by a short paragraph giving particulars as to scale, style of execution, date of first issue, and method adopted for indicating differences of level.

MISCELLANEOUS.

TEXTS OF THE PEACE CONFERENCES AT THE HAGUE, 1899 AND 1907. Edited by James Brown Scott. 447 pp. 8vo. London, 1908. Ginn. 10s. 6d.

A useful book for the student of International Law, each text being conveniently printed with its English translation in parallel columns. There is an exhaustive index, which greatly adds to the value of the edition.

THE POWER TRANSPORT VEHICLE, WITHOUT RAILS, FROM A MILITARY POINT OF VIEW (Der gleislose Kraftwagen in Militärischer Beleuchtung). By W. Stavenhagen. 204 pp., with 11 plates. 8vo. Oldenburg, 1908. Stalling. 3s. 6d.

This book is described in the preface as a scientific treatise, in popular form, suitable for the study of officers of all arms, and for civilians conversant with military matters.

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The contents are arranged in nine parts :—

Part I. is an introduction to the whole subject. Part II. describes the general principles of motor engines and the main characteristics of the different types of motor. The question of roads is discussed and some interesting figures are given for the coefficients of friction on various natures of roadway. This part concludes with some formulæ for the cost of running, tabulated according to speed, type of motor, and nature of the fuel employed.

Part III. is a history of the development of mechanical transport in various countries.

Part IV. deals with the employment of mechanical transport for military purposes. The history of some of the great campaigns from 1812 to 1905 is reviewed with a view to showing what great assistance an up-to-date mechanical transport train could have rendered in these wars.

The author then goes on to discuss the future of motor transport ; he considers that motor cars and motor bicycles will be of use for reconnaissance during the period of mobilization, while mechanical transport trains will perform great service in relieving the strain on railways at certain points, and in carrying on the work of supply, towards the frontier, from the points beyond which it becomes unsafe to use the railways.

For purposes of coast defence motor transport will be exceptionally useful, since there is often no railway available to hurry troops to oppose a threatened landing.

In field operations the greatest service that motor transport can perform is, however, the shortening of the road spaces of the supply columns. On this subject the author gives us some interesting calculations.

It is, however, in siege warfare that the author expects the greatest advantage from mechanical transport. Estimates are given showing the number of tons of ammunition that will be expended daily by a modern siege train, a total far in excess of the capacity of the horse-drawn vehicles available. Again, the materials for the construction of the siege batteries, which must be transported by night from railhead to the sites of the batteries, is estimated at 100 2-horse wagon-loads for one 4-gun battery. Hence for the construction of a line of batteries motor transport appears to be the only solution possible. It is suggested that motors on light rails should be used as tractors, and that in this way 400 guns with their ammunition could be placed in battery in one night.

Part V. contains some useful tables and formulæ. Parts VI. and VII. are appendices. Part VIII. is a supplement relating the progress of mechanical transport in Germany and other countries from 1907 to 1908. Part IX. contains diagrams and photographs of military motor vehicles.

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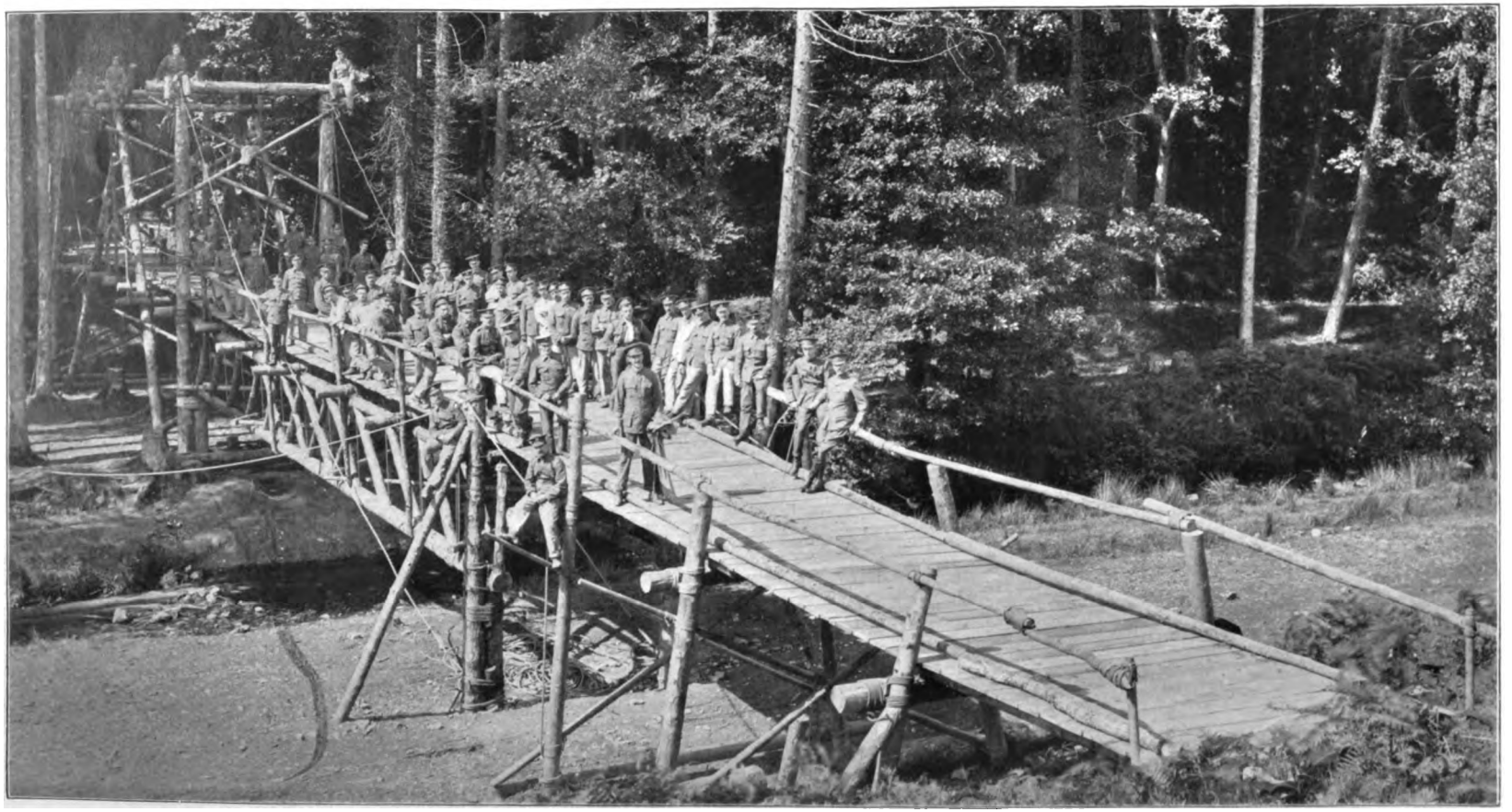
IMPROVISED GIRDER BRIDGES.



End view, showing the whole length of Bridge.

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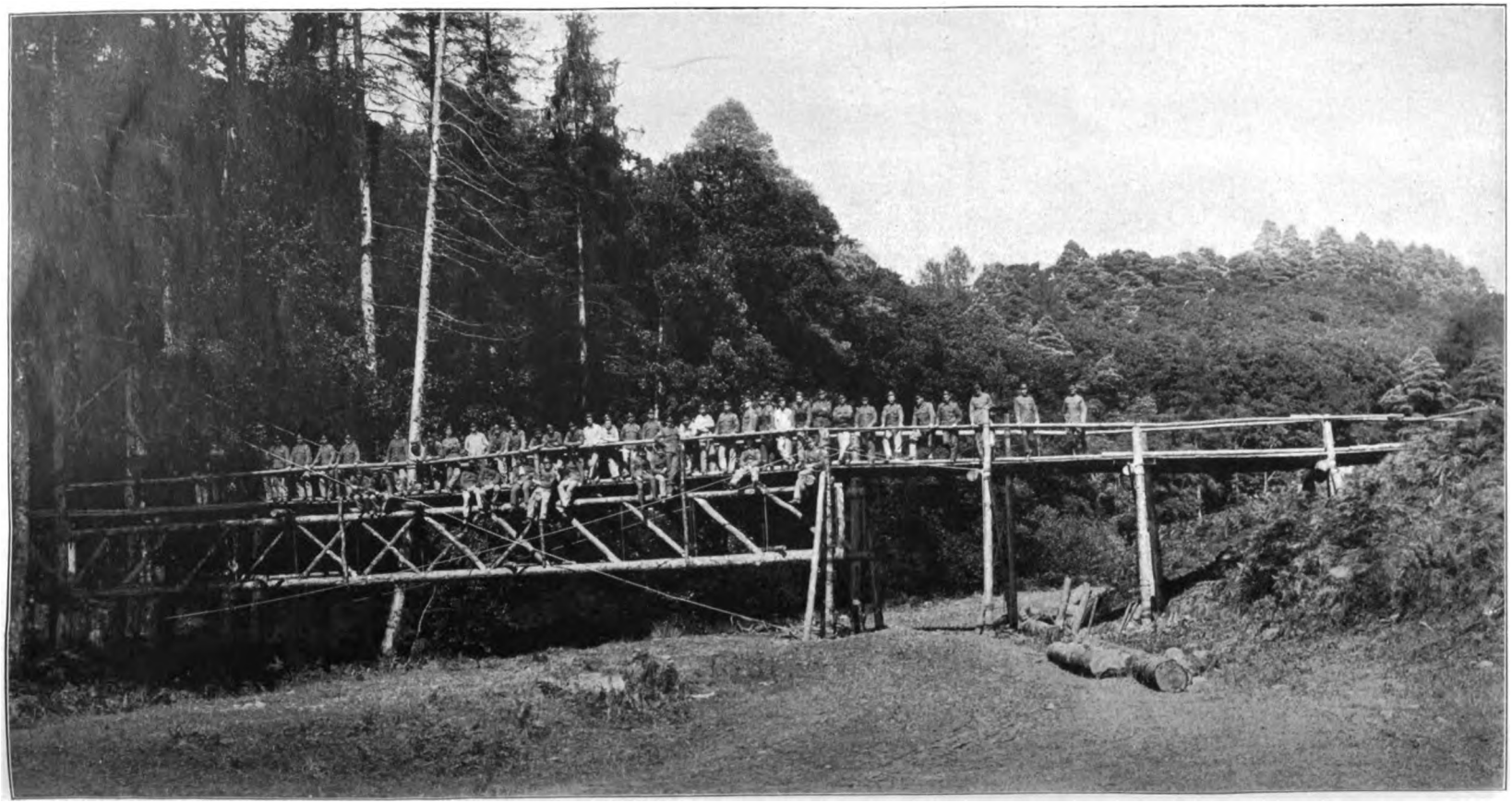
IMPROVISED GIRDER BRIDGES



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IMPROVISED GIRDER BRIDGES.

By CAPT. C. OTLEY PLACE, D.S.O., R.E.

So many articles have recently appeared in the *R.E. Journal* on the subject of bridging expedients in the field, that perhaps some apology is needed when contributing yet another article on the same subject.

My excuse is that I do not remember of late years having seen any account of improvised girder bridges, and I think therefore a short description of a bridge of this nature, constructed by the 38th (Field) Company, R.E., in their last annual course, may prove interesting.

The bridge was constructed across the Valley of Glensiskin, at Kilworth, in August last, the total span being some 218′, and its component parts were :—

(*a*). Treble sling bridge... ... ... 70′ span.
(*b*). Girder bridge ... ... 70′ span.
(*c*). Approaches and trestle bridges ... ... 78′ approx.

The girder and sling bridge being of the same span, it was easy to make comparisons between the two, both as regards efficiency when completed and the time, labour, and material expended in construction, and the advantage was all on the side of the girder bridge.

All the heavy spars for both bridges had to be cut down near the spot.

The girder bridge was formed of two girders placed 8′ apart, and the load was calculated at 5 cwts. per foot-run with a factor of safety of 3. The stresses were worked out graphically, and a complete drawing of the bridge made by Lieut. Collin. The girders were 72′ long, the clear span being 70′. Their depth was 6′, and they were of the ordinary braced girder type with vertical tension members. The latter consisted of wrought-iron bolts made from some old fencing material in the R.E. Yard.

The roadway was some 14′ above the ground, and as the girders were 6′ deep and 1′ had to be allowed for road bearers and transoms, the columns on which the girders rested were 7′ high.

At the trestle-bridge end these columns were lashed inside the legs of the vertical frame, which was made wide enough to allow of this being done. At the other end a vertical frame some 16½′ high was

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erected of the same width, and the two 7′ columns similarly lashed inside the legs.

In each case the girders were raised one end at a time by means of differential tackle made fast to the capsills of the trestles, until they rested on the columns. The two end road transoms were lashed to both girders and vertical frame, and when this was done the capsill of the smaller trestle was removed, and the legs were used to support the handrail.

The flanges of each girder were formed of two trees, butt and tip alternating. The struts were spiked to the flanges, which were checked out to receive them. Great care is necessary when putting the girder together to ensure that the ties come truly vertical.

When the bridge was completed, infantry in fours were marched over without breaking step, and the bridge was perfectly stiff vertically. There was however a certain amount of lateral oscillation due to insufficient cross-bracing from one girder to the other, but this could easily have been remedied had another day been available.

If the construction of such bridges was contemplated in the field, it would be easy to supply 1″ round iron bolts and nuts and stout washers, the bolts being some 8′ long and unscrewed. Then when the depth of the girder had been decided upon, the bolts could be cut and screwed by means of the chest of stocks and dies carried by every field company. This would do away with the delay we experienced by having to make all our bolts and nuts by hand.

Were this done, a girder bridge could be erected in about half the time it takes to put up a sling or suspension bridge of equal span.

All that is needed beyond what is usually found in a fieldwork store is approximately—

1. Four spars equal in length to the gap.
2. One bolt and nut per yard-run of bridge, with 20 per cent. added to the number thus obtained.
3. One strut per yard-run.

The spars and struts have to be cut, and are therefore somewhat damaged for re-issue.

The advantages of such bridges appear to me to be as follows:—

1. They are stiffer than sling or suspension bridges of equal span.
2. They are easier to make.
3. They require less stores to be taken in the field, as the bolts and nuts weigh much less than the cables and lashings which would have to be taken otherwise.

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EARLY TRAINING OF R.E. OFFICERS.

By Capt. C. B. Bonham, R.E.

THE fact of having been thrown in contact a good deal with various infantry battalions during the last three years, and being able to exchange ideas with officers in their Messes, has induced me to consider whether there is not more than the proverbial grain of truth in the opinion, occasionally expressed, that we, as a Corps, are inclined to live and work very much on what may be termed the water-tight compartment system.

With the object of satisfying a legitimate curiosity on this point, I have been at pains to introduce the subject occasionally in conversation with other R.E. officers, and have been led to conclude that there is little practical effort made to obtain real co-operation in training and exchange of ideas between units of other arms and ourselves; in fact, that there is a tendency to perpetuate the separate system.

It is very hard to see that anything but benefit would result from a far more intimate connection in peace training than exists at present between the officers of regiments with whom we have to co-operate in war, and ourselves.

The desirability of enabling officers to become conversant with the working of other arms is inculcated generally in the existing Regulations for Training, but the fulfilment usually leaves the matter in the shape of a piously expressed wish and little further.

No doubt this may be attributed, as far as allotting R.E. officers to work with other units goes, in great part to the pressure of Corps or works duties, which render it very difficult for C.R.E.'s to spare their services for even a day at a time. The contrary aspect of the question may be admitted to present fewer difficulties of this nature, but the acquaintance of even a large percentage of infantry and other officers, with the work of what is *per se* a subsidiary arm, would scarcely afford a working solution of the case.

It is with the former side of the problem therefore that it seems most important to deal. In carrying out R.E. duties we must be vastly more concerned in dealings with infantry, who form the bulk of the fighting forces, than with other arms, and it follows that an intimate acquaintance with that branch is of primary importance to us. Moreover, the early training and subsequent experience of most

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R.E. officers, places them to a considerable extent in contact with artillery work and requirements.

To effect any far-reaching changes on the lines occasionally adopted at present, viz., detailing R.E. officers for a few days to attend battalion training and staff rides, or to lecture to infantry officers and N.C.O.'s, seems to present, as previously indicated, insurmountable difficulties on the score of interfering with current R.E. duties.

It is suggested that a beginning should be made at the other end of the scale, somewhat on the lines recently adopted by the R.A.M.C. in attaching single officers to battalions, not only to practise their profession, but to learn to know the men with whom they will have to deal on service, and their methods.

Four months with a battalion near the commencement of the R.E. officer's service would give him a similar experience, and should go far towards making him feel at home with the Service generally, and with its requirements of every nature.

Some such arrangement would fit in very well with another scheme frequently advocated. I refer to the attaching of officers, on joining, to a Service Company and Works Division before passing through the S.M.E. course, so that they may see for themselves the importance of the training they will get at Chatham—a point not always appreciated by those joining after a stiff course of study at the R.M.A. and the training for the previous entrance examinations.

The whole proposal amounts to this then, that officers should join at Chatham, on being commissioned, for a short course of drill and military duties only, and should then be drafted to service companies at home and in temperate climates for not less than one year, during which time they would be attached for four months or so to an infantry battalion, returning on completion for the S.M.E. course proper.

No attempt has been made to enter into details, but the mere outlines of a suggestion, which it is hoped would prove of benefit to the Service in general and to the Corps in particular, are put forward for consideration as a general problem, touching very closely the maintenance and enhancement of the value of the Corps, to the remainder of the Army.

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MECHANICAL ROAD TRANSPORT IN INDIA.

By Lieut. F. W. Townend, R.E.

A Professional Paper dealing very fully with the question of mechanical road transport in India, and written by Capt. Manley, R.E., has lately been published by the R.E. Institute, and in this it is clearly shown that in many parts of the country the conditions are eminently suitable for the introduction of this form of transport. Capt. Manley has confined himself entirely to the consideration of the steam lorry, the steam tractor, and the ordinary motor car, in considering the problem, but it may interest some of the readers of this Journal to hear that another system has already been tried, namely, the road train.

During February of this year extensive trials of the Renard road train took place on the Gauhati-Shillong road—the very road described by Capt. Manley in his paper. I happened to be staying in Gauhati at the time, and through the courtesy of the manager of the train was permitted to accompany one of the runs. As there is no reference to this type of transport in the above-mentioned paper, a short account of the results of these experiments may be of interest.

The train was the ordinary Renard road train, as used in France and elsewhere. Its general system of working is probably sufficiently well known to most of the readers of the *Journal* by this time, but in case there are any who are unacquainted with it, I will briefly say that it consists of a locomotor, *i.e.*, a 25-h.p. 8-cylinder Daimler motor, with two or three wagons attached. There are several features which cause this system to differ from the ordinary trailer train as seen so commonly on English roads. Chief of these is that each wagon has a pair of driving wheels, and the power, instead of being all applied at the driving wheels of the motor, is distributed to each of the wagons by means of a universally-jointed shaft, which runs the whole length of the train. Thus it may be said that each wagon drives itself. Also, by means of a special steering device, every wagon follows exactly in the track of the locomotor, thus enabling the train to negotiate curves which would be impossible with the ordinary trailer.

The Renard Road Transport (India) Company brought out two

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complete trains at the beginning of the cold weather as a private venture, one going to Bombay, the other to Calcutta. The Railway Board agreed to give the train a trial, and selected the Gauhati-Shillong road for the experiment. Three trial runs to Shillong and back were made, the first being unofficial in order to put things into working order and to enable the driver of the train to get some idea of the road.

The broad results of the trials will be found collected in Tables A, B, and C attached, for which I am indebted to Mr. Lovegrove, of the Ceylon P.W.D. Comparing these with the figures in Capt. Manley's report, it will be seen that they more than hold their own. The consumption of petrol, which is easily procured in the district, works out very economically, and the carrying capacity of the train with three wagons may be taken as 13½ tons, on the basis of 4½ tons per wagon. From the table on p. 33 of Capt. Manley's paper, it appears that one train a day of this nature, would suffice to carry the whole of Shillong's requirements.

As regards the time taken *en route*, this is certainly capable of much reduction, and with drivers acquainted with the road and everything in smooth running order, the distance from Gauhati to Shillong should always be completed during the daylight. During these trials the driver was new to the country and had never seen the road before the first trip, and, as will be gathered from Capt. Manley's description, this is a fairly severe ordeal. The last 6 miles into Shillong, at 1 in 20, were especially trying in the dark, for the improvements mentioned by Capt. Manley were still in hand, and proved rather a hindrance than otherwise. The engine staff also proved insufficient for the task, and they were quite worn out before the journey was completed. This of course had its effect on the consumption of petrol and the speed attained, which under more favourable conditions would have been far better. A driver and at least two mechanics seem to be necessary until they have become familiar with the road. On the first trip we were delayed for three hours on the road owing to the stupidity of a bullock-cart driver, who allowed his cart to sprawl across the road on one of its steepest parts, with the result that in trying to pass it in the dark the near wheels of the last wagon slipped into the ditch at the side of the road, and we had great difficulty in righting things again.

Whether this form of road transport will be finally adopted or not, is a question for the Railway Board to decide; but it seems certain that some type or other will be introduced on this route. The results obtained in the above trials are, on the face of them, very favourable, and given expert driving—which is of course essential with so complicated a piece of mechanism—there seems to be no reason why the Renard train should not prove as efficient as any other means of mechanical road transport.

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TABLE A.—*Particulars of Loads Carried, Weights of Train, Distances Run, Consumption of Petrol, etc.*

	1st February.	5th February.	7th February.	12th February.	18th February.	27th February.
1. Date of trial						
2. Direction	Gauhati to Shillong.	Shillong to Gauhati.	Gauhati to Shillong.	Shillong to Gauhati.	Gauhati to Shillong.	Shillong to Gauhati.
3. Composition of train	Locomotor and 2 trucks.	Locomotor and 2 trucks.	Locomotor and 3 trucks.	Locomotor and 3 trucks.	Locomotor and 2 trucks.	Locomotor and 2 trucks.
4. Tare weight of train	Tons. Cwts. 10 5	Tons. Cwts. 10 5	Tons. Cwts. 13 10	Tons. Cwts. 13 10	Tons. Cwts. 10 5	Tons. Cwts. 10 5
5. Useful load carried	9 5	1 5	14 4	4 18	3 18	2 12
6. Gross weight of train	19 10	11 10	27 14	18 8	14 3	12 17
7. Total distance run, miles	64	64	64	64	65	64
8. Gross ton miles	1,248	736	1,773	1,178	920	822
9. Total ton miles of useful load	592	80	909	314	253	166
10. Total gallons of petrol used	48	29	Unascertained owing to leak in petrol tank.	34	50	37
11. Gallon of petrol used per mile run	0·75	0·45		0·53	0·77	0·58
12. Miles run per gallon of petrol used	1·33	2·21		1·88	1·30	1·73
13. Gallons of petrol used per gross ton mile	0·038	0·039		0·029	0·054	0·045
14. Gallons of petrol used per ton mile of useful load	0·081	0·362		0·108	0·197	0·222

TABLE B.—*Showing Aggregate Time Stopped and Running Time during each Journey.*

	1. 2. 09	5. 2. 09	7. 2. 09	12. 2. 09	18. 2. 09	27. 2. 09
Date of trial						
Direction	Gauhati to Shillong.	Shillong to Gauhati.	Gauhati to Shillong.	Shillong to Gauhati.	Gauhati to Shillong.	Shillong to Gauhati.
Gross weight of train	Tons. Cwts. 19 10	Tons. Cwts. 11 10	Tons. Cwts. 27 14	Tons. Cwts. 18 8	Tons. Cwts. 14 3	Tons. Cwts. 12 17
Total time spent on journey	Hrs. Mins. 17 3	Hrs. Mins. 9 25	Hrs. Mins. 24 0	Hrs. Mins. 11 17	Hrs. Mins. 17 5	Hrs. Mins. 10 19
Time occupied in stops during journey. Voluntary	1 50	1 45	1 39	2 5	1 9	56
Involuntary	3 33	*Nil.*	1 41	30	3 5	9
Total	5 23	1 45	3 40	2 35	4 14	1 5
Total running time	11 40	7 40	20 20	8 42	12 51	9 14

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TABLE C.

Details of Speeds at which the Train Travelled

Date of Trial.	Direction of Journey.	Section of Road Miles.	Average Speed. M.P.H.	Useful Load. Tons.	Useful Load. Cwts.	Gross Load. Tons.	Gross Load. Cwts.	Remarks.
1. 2. 09	Gauhati to Shillong.	0·75 to 6·00 6 ,, 44·75 14·75 ,, 64·75 0·75 ,, 64·75	8·00 6·50 3·92 5·48	9	5	19	10	Daylight failed at 43rd milepost. 21¾ miles travelled after dark. Time spent on journey, 17 hours 3 mins. 3 consecutive miles run at speed of 11 M.P.H.
5. 2. 09	Shillong to Gauhati.	64·75 ,, 54·00 54 ,, 7 7 ,, 0·75 64·75 ,, 0·75	7·97 8·34 9·15 8·35	1	5	11	10	Trial finished in daylight. Time spent on journey, 9 hours 25 mins. 3 consecutive miles run at speed of 10 M.P.H. 1 mile at 12 M.P.H. twice.
7. 2. 09	Gauhati to Shillong.	0·75 ,, 7 7 ,, 54 54 ,, 64·75 0·75 ,, 64·75	6·70 3·51 1·79 3·15	14	4	27	14	Daylight failed at 23rd milepost. 31¾ miles travelled after dark. Time spent on journey, 24 hours. 5 consecutive miles run at speed of 7·14 M.P.H. 1 mile at 7·5 M.P.H. twice.
12. 2. 09	Shillong to Gauhati.	64·75 ,, 54 54 ,, 9 9 ,, 0·75 64·75 ,, 0·75	7·50 7·28 8·08 7·35	4	18	18	8	Daylight failed at 10th milepost. 9¾ miles travelled after dark. Time spent on journey, 11 hours 17 mins 3 consecutive miles run at a speed of 9·5 M.P.H. 1 mile at 10 M.P.H. twice.
18. 2. 09	Gauhati to Shillong.	0 ,, 7 7 ,, 50 50 ,, 65 0 ,, 65	7·37 5·26 4·02 5·06	3	18	14	3	Daylight failed at 51st milepost. 14 miles travelled after dark. Time spent on journey, 17 hours 5 mins. 3 consecutive miles at speed of 10 M.P.H. 4 consecutive miles at 9·75 M.P.H. 1 mile at 12 M.P.H.
27. 2. 09	Shillong to Gauhati.	64·75 ,, 54 54 ,, 7 7 ,, 0·75 64·75 ,, 0·75	6·86 6·68 9·87 6·93	2	12	12	17	Trial finished in daylight. Time spent on journey, 10 hours 19 mins. 3 consecutive miles run at speed of 11 M.P.H. 6 consecutive miles at speed of 10·30 M.P.H. 1 mile at 12 M.P.H. twice.

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NOTES ON SOME AMERICAN BATTLEFIELDS.

By 'MILES.'

WHILE travelling on leave in the United States in the autumn of 1908, the writer took the opportunity of visiting some of the battlefields in Virginia and Maryland, and the following notes may possibly be of interest to those who have studied the history of the Civil War. It is presumed that anyone who reads this article is already familiar with the main outlines of the campaigns of 1863 and 1864, and it will therefore be unnecessary to give any description of the operations, except in so far as a brief outline of some special incident may be necessary to elucidate the remarks made on the battlefield in question. The writer had the good fortune to make the acquaintance at Fredericksburg, Virginia, of an ex-Confederate officer—Capt. Murray-Taylor—who served throughout the war on the staff of General A. P. Hill, and formed one of the small group of staff officers who accompanied Jackson on his reconnaissance down the plank road toward Chancellorsville on May 2nd, 1863, having his horse killed under him by the same volley that mortally wounded Jackson. He was also at the side of A. P. Hill when he was killed in Grant's final and successful assault on the Confederate lines round Petersburg. To Capt. Taylor the writer is indebted for much kindness and hospitality, and for a great deal of most interesting information about incidents in the battles fought round Fredericksburg.

It is hardly an exaggeration to say that Fredericksburg has witnessed more fighting in its immediate neighbourhood than any other town on either side of the Atlantic. Within a radius of 12 miles there were four great battles fought in two years, Fredericksburg in December, 1862, Chancellorsville in May, 1863, and the Wilderness and Spotsylvania in May, 1864. In these battles the casualties on both sides reached a total of over 100,000 men. What lends a particular interest to the study of the ground over which these battles were fought, is the fact that it lies to-day in almost exactly the same condition as it was 45 years ago. Part of Fredericksburg has been rebuilt, but for the most part it remains the same quiet, self-contained country town that it was before the war. Its inhabitants can still point out on the walls of some of the houses, the marks of cannon balls recalling General Burnside's bombardment previous to the battle of December, 1862, when the greater part of the town was laid in

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ruins. Salem Church, a quaint little red-brick building on the plank road 3 miles out from the town, still shows the marks of the bullets it received during Sedgwick's attack on May 4th, 1863. Further west one can follow for miles through the woods, the entrenchments made by the armies of Lee and Grant. But for a slight filling up of the ditches, these remain in exactly the same condition as in when vacated by the troops in 1864. The only considerable alteration that has been made in any part of the four battlefields, is the formation of the large National Cemetery on Marye's Hill, behind Fredericksburg, the scene of the disastrous Federal assaults in Burnside's battle. The celebrated stone wall—which formed the front line of the Confederate position on the hill—is still there and remains practically untouched. At the foot of the hill, there now stands a monument to General Cobb, who was mortally wounded while in command of the Confederate troops at this point. Readers of Henderson's *Stonewall Jackson* will remember his moving description of the last interview between Cobb and Jackson on that occasion.

Turning to the battlefield of Chancellorsville, the Chancellor House, which was partly burnt down at the time of the battle, has since been rebuilt. At the present time it stands unoccupied and in a somewhat dilapidated condition, looking in fact much as it must have appeared on May 3rd, 1863, when the enemy's shells were bursting over it, in the final Confederate assault on that day. One can still see the pillar against which Hooker was leaning when the bursting of a shell, which struck the house, threw him senseless to the ground. The wide clearing in which the house stands, remains as it was at the time of the battle. All around it lie the dense thickets of the Wilderness, while round the western edge of the clearing, one can still trace the epaulements thrown up for the guns which were hurriedly placed here by General Pleasonton, to resist Jackson's final attack. Following the plank road for about three-quarters of a mile, one comes to the spot where Jackson was standing with his staff when the fatal volley was fired which mortally wounded him. The account of this disaster, as told to the writer by Capt. Taylor, who was at the time lying on the road pinned beneath his fallen horse, agrees in almost every respect with the wonderfully graphic description by Henderson. A monument has been erected to Jackson under the trees by the roadside, as near as possible to the spot where he fell. It is a plain column of dressed granite, bearing on it the simple inscription "Lieut.-General T. J. Jackson, C.S.A. Died May 6th, 1863," and under this are inscribed the words used by Bee at Bull Run, "Look, there is Jackson standing like a stone wall!" From this point it is easy to form an idea of the situation at that moment as it must have presented itself to Jackson's mind. In front, the plank road, about 40′ wide, runs in a dead straight line towards Chancellors-

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ville through the woods on either hand, the house itself being only hidden from view by a slight intermediate rise in the ground. That house formed Hooker's headquarters. The rout of the Eleventh Corps had left the road absolutely open, for with the exception of a few regiments hastily collected together from different quarters, and the Federal batteries massed round the edge of the clearing, there was nothing to oppose the Confederate advance to Chancellorsville. Standing there beside the monument and looking down the plank road, one can realize clearly how it was Jackson's untimely fall—and with it the removal of the directing brain of the Confederate assault—that alone saved Hooker's headquarters from capture and his army from a terrible disaster.

It is a curious fact that the exact route, followed by Jackson in his march round Hooker's right flank, remains more or less uncertain. The generally accepted route is that indicated by Henderson in the map of the battlefield attached to his *Stonewall Jackson*, Vol. II. But it seems doubtful whether the column could have covered so long a distance, as is here indicated, in the time which the march is recorded to have taken. Capt. Murray-Taylor, who accompanied the column and was intimately acquainted with the ground, informed the writer that he himself was uncertain as to which was the road actually followed. Nor is this to be wondered at when one has seen the Wilderness and realized how like each other all the forest tracks are. It will be remembered that Jackson obtained the services of a local guide to lead him through the woods, and it can be easily understood how, in the excitement and preoccupation of the ensuing battle, the details of the march may have passed out of the recollection of those who took part in it. The spot where Lee and Jackson held their last consultation, is marked by a small stone with a brief inscription chronicling the fact, set up at a point where a branch road from Catherine Furnace runs into the plank road within a mile of Chancellorsville. This is one of the very thickest parts of the Wilderness, and it is easy to understand how possible it was for Lee to conceal from Hooker the smallness of the force still facing him, and to amuse him by feint attacks on his front at Chancellorsville, while Jackson, concealed by the forest, was marching round to fall upon his flank and rear.

The battlefield of Spotsylvania is in many ways as interesting as that of Chancellorsville. Wandering through the woods one comes upon trenches, rifle pits, and gun epaulements everywhere, line after line, sometimes three deep, often in the most unexpected places, and running in every sort of direction. Relics of the battle, in the shape of bullets, fragments of shells, rusted bayonets, etc., can still be picked up in large numbers. They are genuine relics, not *imported*

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ones, such as those which are brought in cart loads and dumped on the site for the amusement and gratification of tourists at Waterloo and other famous battlefields. There are no tourists to cater for at Spotsylvania, for none go there. The battlefield remains in exactly the same condition to-day as when it was evacuated by Lee and Grant in May, 1864. Its most striking peculiarity is the absence of any well-marked natural features. The position occupied by the Confederates, followed the contours of the low crest which forms the water parting between the two little streams—the Po and the Ny. The greater part of this ground is covered with thick woods, except in the neighbourhood of the Court House, where it is fairly open. Lee must have had a wonderful eye for ground, for this position, taken up at a moment's notice almost in the presence of the enemy, was the best that could have been found anywhere in that vicinity. Its good points are shown by the fact that during the 15 days the battle lasted, Grant tested every portion of the line, and expended from 15,000 to 20,000 men in vain efforts to break through. Only at one point can the position be said to have been defective. This was at the famous salient, or "Mule Shoe," the scene of the desperate fighting on May 12th. This action affords an excellent example of the extraordinary nature of the fighting in such a locality as the Wilderness. Lee's line at this point formed a very prominent salient—shaped somewhat like a horse-shoe—following the edge of a thick wood, which had been prepared for defence by constructing breastworks of logs. In front stretches an open space about 400 yards wide, separating the salient from the belt of woods which marked the Federal line. On the night of May 11th, Grant, unknown to the Confederates, massed Hancock's Corps opposite the salient. The assault was delivered at dawn of the 12th, a heavy mist concealing the attacking troops until they were within a short distance of the enemy's line. The breastworks were carried with the bayonet almost without a shot being fired, and part of the attacking column running down a lane, which gives access to the base of the salient, got in rear of, and captured, Johnson's Division, which was holding the angle. Had Hancock been able to follow up the success so brilliantly won, Lee's Army might have been destroyed. But his troops had lost all order in their advance, and the dense thickets prevented them from realizing the extent of their success. Lee brought up reinforcements from Hill's Corps on his left, and the Federals were forced back to the breastworks they had just captured. Here the struggle continued for hours, the Federal and Confederate troops shooting and stabbing one another across the breastworks. So shocking was the aspect of the ground after the battle, that this corner of the line came to be called the "Bloody Angle." Finally Lee withdrew his troops to a fresh line of entrenchments which had

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been rapidly thrown up across the base of the salient, and so the fighting ended. For many years there stood here the stump of a tree which had been cut in two by the rain of bullets during the struggle for the breastworks, but it has now gone. A monument has been put up at the "Bloody Angle" to a Massachusetts regiment which lost 60 per cent. of its strength in this fearful *mêlée*. It is a pity that no memorial of any sort has yet been erected to the memory of the brave men of Gordon's Confederate Division who faced them for so many hours on the other side of the breastworks.

An examination of the ground shows clearly why the salient was selected. It is the only position in this vicinity from which a good field of fire can be obtained to the front and flanks. Everywhere else the dense woods make it impossible to see 20 yards ahead. This is shown clearly by the remarks on the fighting at the salient which General John Gordon makes in his *Reminiscences of the Civil War*. All that he heard of Hancock's assault were a few scattered shots, followed by a mysterious silence. No one knew what had happened, and all that Gordon could ascertain was that a large body of the enemy seemed to have broken through somewhere near the salient, and was apparently moving in rear of the Confederate lines. The statement appears incredible until one realizes how restricted is the view in these thick woods, which are quite large and dense enough to have swallowed up the whole of Hancock's Corps from sight or sound.

Another battlefield which the writer visited was Gettysburg. The contrast between this field and that of Spotsylvania is a most striking one. The principal characteristic of Spotsylvania, as already noted, is the absence of conspicuous features. Gettysburg, on the other hand, is one of the most well-marked battlefields to be found anywhere. The one is covered with dense woods; the other is, for the most part, very open ground. The maximum range at Spotsylvania was a few hundred yards. At Gettysburg batteries came into action at over 2,000 yards range. There is scarcely a monument of any sort at the former. At the latter there are between 400 and 500. In this respect Gettysburg must certainly hold the world's record. In some places, particularly on Cemetery Ridge, there are so many that they seem to almost jostle one another for space, producing a somewhat incongruous effect. A single adequate monument, dedicated to the memory of all the regiments that fought at this point, would probably be much more impressive. The whole of the ground over which the battle was fought has been taken over by the United States Government and converted into a National Park. Under the direction of a Board of Com-

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missioners much has been done to make it attractive to visitors. Avenues have been laid out in all directions, following in many places the positions taken up by the hostile lines; observation towers erected, from which excellent views over all parts of the field can be obtained; and guns, actually used during the war, have been placed to mark the positions occupied by the artillery on both sides during the battle. All this makes the study of the battlefield most interesting, although it may be doubted whether the alteration of the natural features of the ground, by the construction of the numerous avenues, is altogether a good thing. Lieut.-Colonel Cope, U.S. Engineers, one of the National Commissioners, who was himself an eye-witness of the battle, gave the writer much interesting information, and was most kind and obliging in every way.

In all descriptions of the natural features of the battlefield much stress is laid on the importance of the Cemetery and Seminary Ridges, which formed the positions of the Federal and Confederate Armies respectively on the second and third days of the battle. It is surprising therefore to find how relatively insignificant these two ridges are. Cemetery Ridge is in reality only a slight swelling or corrugation of the ground, which would be barely perceptible but for the broad glacis slope, absolutely bare and open, which it presents to the west. Cemetery Hill—described by one writer as a "bold promontory" and by another as a "rocky headland"—is not a conspicuous feature by any means. It is an oval-shaped hill with easy slopes on all its faces except the east, where the gradient is steeper. The expression, often used, that from the summit of the hill one looks down into the streets of the town, gives an exaggerated impression of its height and abruptness. Surveying the Federal position from the Lutheran Seminary, which stands on the ridge of that name, the conspicuous points that strike the eye are Culp's Hill, rising up behind the town on the left, and Round Top or Sugar Loaf Mountain looming up in the distance on the far right. But for the tall monument which stands in the cemetery grounds, Cemetery Hill would escape almost unnoticed. The same may be said for the Seminary Ridge, which played an almost equally important part in the battle. It forms not so much a "ridge" as an "escarpment," the slope being sometimes on one side, sometimes on the other. Thus the south end of the ridge, from which Longstreet's assault on July 2nd was delivered, shows from the Federal position simply as a dark line of woods, seen across a wide stretch of flat fields. Behind this belt of woods the ground falls away sharply towards a stream called Marsh Creek, and it is this escarpment that constitutes the so-called ridge.

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The most celebrated episode in the Battle of Gettysburg is undoubtedly the famous charge of Pickett's Division on Cemetery Ridge. This is as much an historic event in America as the charge of the Light Brigade at Balaclava is in this country. The circumstances are, no doubt, familiar. General Lee's intention was to break through the centre of the Union line holding Cemetery Ridge, and for this purpose he formed an assaulting column of some 14,000 men, composed of Pickett's Virginian Division and a mixed division under Trimble and Pettigrew. It was intended that the remainder of A. P. Hill's Corps should support the attack, but owing to a blunder, which has never yet been satisfactorily explained, the order miscarried and the two divisions advanced entirely unsupported. Trimble and Pettigrew were beaten back, without crossing bayonets, by the terrible cross fire of artillery and small arms, but Pickett's Division, in spite of the most frightful losses, succeeded in reaching the low rubble wall which formed the enemy's front line and planted their flags on Cemetery Ridge. Had the supports been now at hand Pickett might have made good his foothold, but not a man was sent, and after a desperate hand-to-hand struggle over the stone wall, the Virginians were forced back and the assault ended in complete failure. In this charge Pickett's Division lost every field officer and 2,843 rank and file, out of 5,000 who took part in the attack. An examination of the ground, over which this celebrated charge was made, forms a most interesting study. Many descriptions of the attack speak of the Confederate columns advancing "to storm the heights." This is misleading. The track followed by Pickett's Division leads across a perfectly flat plain, about 1,000 yards in width, until the Emmittsburg road is crossed, when the ground rises slightly towards the low crest of Cemetery Ridge. The strength of the position lies not in the difficulties of a steep ascent which is non-existent, but in the broad glacis slope without a vestige of cover, over which the attacking troops had to advance to the assault. This spot has been called the High-Water Mark of the Confederacy, from the generally accepted opinion that had Pickett been adequately supported the Confederates would have won the battle, and the South the recognition of her independence. At this point there stands the only Confederate monument on the battlefield. A granite scroll about 3′ high marks the spot where General Armistead fell at the head of his brigade in the heart of the Union lines. It bears the plain inscription "Brigadier-General Lewis A. Armistead, C.S.A., fell here July 3rd, 1863." Amidst the vast number of stately and imposing edifices which crowd the Cemetery Ridge, and are erected to the memory of Union officers and men, this simple tribute to a Confederate soldier has the most impressive

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effect, constituting as it does the sole memorial of one of the finest feats of arms recorded in history.

There are many other most interesting incidents in this the decisive battle of the war, but considerations of space prevent a reference to them in this article.

In conclusion, the writer of this article would like to record not only the unfailing kindness and courtesy with which he was met wherever he went in Pennsylvania, Virginia, and Maryland, but also the great willingness on the part of those whom he met to give him any information and assistance in their power.

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ROMAN AND EARLY BRITISH TERRITORIALS.

By COLONEL S. A. E. HICKSON, D.S.O., R.E.

THE details of the decline of the ancient Roman military system of the republic, by Colonel O. E. Ruck in the *R.E. Journal* for May, are of particular interest, more especially as he gives references. All your readers however may not be acquainted with the ancient Roman republican constitution as a whole, or such records of it as still exist, and were so carefully examined early last century by Niebuhr, whose investigations were continued by Mommsen. This constitution, generally known as that of Servius Tullius, is thus described by Mommsen :—" Under the Servian constitution the duty of service and the obligation connected with it of making advances to the State in case of need (*tributum*), instead of being imposed upon the possessors of the land, the domiciled or freeholders (*adsidui*), or the wealthy (*locupletes*), whether they were burgesses or merely *metoeci*, service in the army was changed from a personal burden to a burden on property." This is just what Dr. Stubbs in his constitutional *History of England* describes as taking place in this country during the Saxon period. In the Roman system Dr. Mommsen continues : " Every freeholder, from the seventeenth to the sixtieth year of his age, was under obligation of service, including children in the household of fathers who were freeholders, without distinction of birth; so that even the emancipated had to serve, who in an exceptional case had come into possession of landed property. . . . The body of men liable to serve was distributed according to the size of their portions of land into five summonings (classes from *calare*). Of these however only those liable under the first summoning or those in possesssion of an entire hide of land were obliged to find complete armour, and, in that point of view, were pre-eminently regarded as " those summoned to war service" (*classici*). The four following ranks of smaller land owners, the possessors respectively of three-fourths, of a half, of a quarter, of an eighth of a normal hide, were required to fulfil service, but not to equip themselves in complete armour." It is from this system that we have our own word " class," and upon this system was founded that splendid early English system of national defence, which merged from the Saxon *Trinoda necessitas* and " fyrd," and from the Oath of Allegiance which bound every Englishman by service to the King. The " Assize of Arms" of the reign of Henry II., in which this English system first took written form, follows exactly the lines of the Constitution of Servius Tullius, its first three clauses running as follows :—

(1). Quicunque habet feodum unius militis habeat loricam et cassidem clypeum et lanceam, etc.

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(2). Quicunque vero liber laicus habuerit in catallo vel in redditu ad valentiam de XVI. marcis, habeat loricam et cassidem et clypeum et lanceam, quicunque vero liber laicus habuerit in catallo vel redditu X. marcas habeat aubergel, et capellet ferri et lanceam.

(3). Nem armes burgenses et tota communa librorum hominum habeant wambais et capellet ferri et lanceam.

Thus in England there were four classes. The system of universal obligation to military service, thus founded, was expanded under the Statute of Winchester of Edward I.; and there were many revisions of it, especially by Henry VIII. It continued to be the mainstay of our national defence up to the time of the Spanish Armada, when it fell into disuse by reason of the argument of the extreme blue-water school, which then came into existence under the title of "Worshippers of Neptune." As in the case of Rome, universal service gradually decayed away and the Imperial legions, formed of professional soldiers, took its place; so in England the "fyrd," *i.e.*, the national levy or militia, was replaced by a standing army, raised when occasion demanded or panic arose, and disappearing with the swing of the pendulum to peace. We have thus now no self-supporting continuous system such as we had up to the sixteenth century, when in 1557 a Venetian ambassador reported as follows to his Government concerning it:—"As to the land forces (of the English), aptness, courage, and inclination supply the deficiency of other qualities, and when in action no natives in any quarter of the world fight with an equal degree of ardour and contempt of death. . . . As the hopes of a country rest principally on the valour of the rising generation, boys from the age of nine are taught to draw the bow, in the use of which their dexterity is incredible. There are few who cannot lodge the arrow within half a palm of the mark. In the more experienced, force is so effectually united with dexterity that they are reported to pierce not only the corslet, but a complete suit of armour." A note explains further that "An English arrow with a little waxe put upon the point of the head will passe through any ordinary corselette or curace." Hume (Vol. I., p. 67) also relates how King Alfred, "after rebuilding the ruined cities, particularly London, which had been destroyed by the Danes in the reign of Ethelwolf, established a regular militia for the defence of the kingdom. He ordained that all his people should be armed and registered." He had besides a central force consisting of his thegns and ten trained men from every town, and the scientific use he made of this central force, combined with the local territorial levies of London, Kent, and Surrey at one time, and of Devon at another, etc., etc., in driving off the Danes when they came again in 893 and attacked simultaneously the north and south of Kent and Exeter, is well worth studying.

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FIRE APPLIANCES IN BARRACKS.

SOME NOTES ON WORKING.

By CAPT. E. H. HARVEY, LATE R.E.

THE following notes and suggestions have been put together in the hope that they may be of some use to Division Officers, R.E., in connection with various small questions affecting fire appliances and water supply in barracks, that often arise in the course of daily work.

To officers of experience I am afraid that many of the points alluded to will appear trivial and to possess no novelty, but there are some who may not have had much occasion to deal with the matter, and as information on the subject of fire appliances exists in rather a scattered form, and as the D.O., R.E., is from time to time referred to for advice on fire-protective arrangements, perhaps the following may be of service in connection with certain points which I have known to give rise to correspondence and minor difficulties.

I have in previous papers gone more fully into the technical side of the question, and will therefore confine myself to some practical suggestions.

Water Supply.—The importance of having fire mains of ample size is now well known, and in testing any system it is essential to ascertain that the required supply can be continuously maintained, keeping the hydrant jets at work for some little time, and noting whether any serious variations occur through the opening of other branches and services. A main, though theoretically large enough to deliver an adequate fire supply at its extreme end, is frequently liable to be temporarily affected by the above cause, and therefore a margin should be allowed to counteract these draughts of water for domestic supply, and to give a fair chance of obtaining sufficient for immediately dealing with an outbreak of fire. It is needless to say that in many cases a poor pressure at the commencement can never be compensated for by the full supply when it is too late.

Supply from Hydrants.—Where the hydrants have to supply fire engines more frequently than direct jets it is most important that the delivery should be ample; 350 to 400 gallons per minute should be allowed for the supply of an average-sized steamer, and 500 gallons for larger engines.

Special meters can now be obtained for ascertaining the rate of delivery from hydrants, but a rough-and-ready way is, of course, by taking the time of filling a tank of known capacity. I have effected

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this with a 100-gallon cistern (from store), a standpipe, and a very short length of leather hose, similar to that which would deliver the water into the canvas "dam" or the cistern of an engine. The water must be fully turned on and running full-bore before the end of the hose is (quickly) dropped into the tank and the timing commenced. This method of testing, though simple, requires to be carefully done, to ensure a fairly accurate result.

New Hydrants.—When new barrack works are being completed it is very important to see that subsequent to the laying down of the hydrants any making up of the roads and parades has not caused the level of the outlet and key-spindle to be too deep below the surface. It may even be necessary to fit a lengthening piece to the outlet and lengthen the water key, though with careful levelling there should not be much mistake.

Hydrant covers, again, may be carelessly covered up with gravel, and it is most desirable before handing over new hydrants to see them *all* tested with standpipe and key, and if possible hose and branch-pipe, so as to make certain that the supply is equal to what was provided for.

Marking Hydrants.—Barrack hydrants, being often in the middle of large gravelled surfaces, are not always easy to locate at night. It is a great help if the iron covers are painted white and then lime-whited, the limewhite being renewed periodically by the regimental conservancy men or pioneers, who should have a list of the hydrants and thus become well acquainted with their positions. Even when they have become rather faded from the effects of rain, the covers are still easily seen on a dark night. In snowy weather the distance from the wall-mark will require measurement in any case, if the hydrant has to be picked up.

On the wall-marks of hydrants and sluice valves it may in some cases be well to paint arrows showing the direction for turning "on" or "off."

By-pass.—To ensure that the by-pass is not allowed to get set fast, a local arrangement should be made with the Water Company for it to be periodically turned on in the presence of their representative, who will then re-seal it. This occasion, with the concurrence of the O.C. troops in the station, is a favourable opportunity for thoroughly practising fire drill with all available appliances, and also for affording the local public fire brigade an opportunity of testing the supply, with reference to the capacity of their own engines. A list of approximate dates on which the by-pass is turned (say quarterly) may with advantage be kept on the wall of the D.O.'s Office, together with a list of the hydrants (and fire tanks, if any).

In practising fire drill it is of great importance that some reliable men should be *permanently* told off at all fire alarms to attend to and, if necessary, actually turn on the by-pass. And a particular point

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to notice is that immediately the by-pass has been turned on, a sentry or policeman should be posted on it to prevent interference, unless ordered by the senior officer present. It is most desirable that the men who have this duty should be practised in actually opening the valve, for, as people will know who try it, it is not quite as easy to start a sluice valve which may be a little stiff as would appear in theory. And in regard to the posting of the sentry, I have heard of a case at a serious barrack fire in which the by-pass, after being once turned on, was shut off again, with the best intentions, by a later arrival, who thought he was opening it.

Sunk Tanks.—Sunk tanks, though a necessity in many isolated situations where there are no water mains or only a small domestic supply, have the objections pointed out in a book written many years ago by Mr. Braidwood—the chief of the first large organized fire brigade in London* and the predecessor of the late Sir E. M. Shaw—that they confine the engines to particular spots, often necessitating, if not very numerous, long lines of hose, and that they are sometimes too small, leading to a failure of the water at perhaps a critical moment. As a storage of water for commencing operations, where there are hydrants which can be charged with water soon after an outbreak, though ordinarily under intermittent service, tanks have, of course, their value. In the Winchester barracks, as a "first-aid" measure, three large 1,400-gallon cisterns over latrines adjacent to a large range of buildings were fitted with 3″ outlets and suction-hose connections, so as to enable a manual engine to commence work till the hydrants were turned on. Ordinarily however a reserve tank, even if only for "first aid," should hold at least an hour's supply for the barrack engine at full power.

Siting Tanks.—In placing tanks for the protection of any building it is very desirable to consider the direction of the prevailing winds and, if possible, to arrange *two* or more tanks, so that alternative positions may be found for the fire engines if a strong wind is blowing. Otherwise, as in a case I have heard of, the only available tank may be close to leeward of the fire, and the men unable to work for heat and smoke. Another point to remember in barracks is the limited range of the manual engine, especially if the building to be protected is of any height. It will always be useful in considering the protection of any buildings, whether new or existing, to practically test the engine on the furthest points of the roof from the water supply, and so find out its radius of action, before setting out any tanks.

Manual Engines.—The standard engine now used by the War Department is the "No. 1," or large size; the small "No. 2" engines are being expended by degrees, but are yet to be found in service. Useful as light appliances for very small buildings in steep hilly

* The "London Fire Engine Establishment."

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places, their capacity cannot be said to be great, and, besides being of inferior power, they use both a smaller suction ($2\frac{1}{4}$″) and a smaller delivery hose ($1\frac{1}{2}$″) than the "No. 1" manual, which takes the standard size of hose used by most public fire brigades ($2\frac{1}{2}$″).* Where the two sizes of engines are in use together there is always risk of some confusion with the different-sized hose connections, involving the use of various "adapters." The manual engine, it may be observed, is often described in terms of the bore in inches of the pump cylinders, "No. 1" being a "7″ engine." A very widely-used size in England is the "6″ engine," this size having been adopted in London during the time of Sir E. M. Shaw's command, previous to the full equipment of the London Fire Brigade with steamers.

The 7″ engine (the same size as the War Department "No. 1") was preferred by Mr. Braidwood, but in his time the steam fire engine was in its infancy and London fires had to be dealt with by manual pumps.

It must be remembered that in buildings of small height and moderate dimensions a great deal of useful work has been done in the past and can still be done by manual engines. One objection to their use, though, of course, not the chief one, viz., their lack of power for many modern conditions, is the difficulty of always getting labour at once when required, especially in rural out-districts or in the dead of the night in residential localities. This condition does not exist in barracks and similar institutions, and these engines will always have their use, at least as "first aid," till steam appliances can be got into action; for instance, where a steamer is maintained at a works or at a Government establishment, and where there may be no facilities for keeping the boiler hot, and also a poor pressure on the hydrants to rely on while steam is being raised from cold water.

Notes on Working Engines.—Dealing now with one or two points that come to notice at ordinary fire practices, it is particularly important that all soldiers who have to do with the barrack fire engine should thoroughly understand the use of the valve on the suction pipe (worked by a handle in the rear "well" of the engine), which sets the pump to draw water either from the "well" itself or through the suction inlet and hose.

This may seem a trifling thing to allude to, but I have several times seen men in charge unable to get their engine to work through lack of this information,—the handle happening to be turned the wrong way. Also the valve should be turned to and fro periodically, or it is certain to get set fast.

Mode of Supply of Water.—A certain amount of difficulty arises at times in making connection between the engines and various-sized hydrants, and the R.E. are referred to. There is however no

* The figures in brackets denote size of waterway in the hose couplings, *i.e.*, their internal diameter.

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difficulty if the simple course is adopted of providing a short length of hose which fits the standpipe and hydrant, and putting the open end of it in the engine "well," turning the handle of the suction valve above alluded to *across* the engine.

The "break of gauge"—to use a railway expression—then occurs at the engine, and it is no matter whether the delivery hose and connections (other than the length referred to above) fit the hydrant or not. I have seen difficulties arise, leading to correspondence, because of it being apparently thought essential that the suction hose should be connected *direct* to the standpipe on the hydrant.

This is apt to come to notice in places where a barrack is provided both with hydrants and sunk tanks, and the engine is worked from either in turn.

Connecting Direct with Hydrants.—Adapters, known as "screws, double junction," for connecting the "No. 1" engine suction, with outlet of standpipe, are double-ended screw collars forming an article of store, and provided by the A.O.D. for use in cases where it is specially desired to connect the engine suction *direct* to the standpipe. This method of working has certain advantages, especially where the water pressure on the mains is intermittent, as at high levels,—the suction of the engine in such cases tending to hasten the flow of water in the hydrant, and, on occasion, enabling a jet to be got to work more quickly.

To summarize the foregoing remarks, it may be mentioned that there are three ordinary ways of supplying the manual with water.

(1). Through the suction inlet and suction hose (with strainer), handle of suction valve turned "*fore-and-aft*" in the engine, as when lifting from a stream or tank.

(2). The same, but with the suction hose connected direct by means of a "double junction" screw to a standpipe.

(3). From the "well" of the engine itself, with the handle of the suction valve turned *across the engine*, and the end of a hose from a hydrant (or in some cases from another engine nearer the water supply) placed in the "well."

For the reasons already given, this last is the most generally convenient way of working from hydrants. A short curved copper bend—known as a "goose-neck"—is provided to attach to the open end of the supply hose, and hook on the side of the engine "well."

Placing the Engine for Work.—In working from hydrants, though *usual*, it is by no means *necessary* that the engine should be placed close to the hydrant—unless directly connected thereto—and by a little experiment it will often be found possible to greatly increase the effective radius of action of a hydrant aided by an engine by stationing the latter near the building to be reached and laying down a line of several lengths of hose between

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it and the hydrant. The latter will often have force enough to deliver a good supply at low pressure through a long line of open hose to a point quite near a building, where the engine can then be placed, and throw a jet that will cover the roof. To give two instances that I have tested, the top floor of a three-storied barrack block standing back in an enclosure was, at its furthest end from the nearest available hydrant, quite out of reach either of a jet from the hydrant *direct*, with a low pressure of about 25 lbs. per square inch, or of the jet from the manual when worked *near* the hydrant with the short length of hose supplied for the purpose. But by laying about 150′ of hose between the engine and hydrant the former was brought to a close range, which easily enabled it to cover the building.

In another case about 250′ of hose were required to reach some one-storied workshops, and the jet from the manual, (a rather old one in this case), when near the hydrant, and that direct from the hydrant itself, were equally feeble; but on moving the engine up to the front, 200′ from the standpipe, and filling it from the open end of the hose, the quantity of water was still found adequate, and a full-powered jet was thrown at short range.

This method of working is worth testing in any case where there is difficulty in reaching outlying parts of the barracks, though, of course, the more hydrants the better. It has been said that hydrants are cheaper than hose in the long run, and the less the length of hose through which the water has to be forced, the better the result, especially with the unlined canvas hose.

Ladders and Fire Escapes.—In dealing with many fires it is of utmost importance to have efficient means for getting on to the roof, and it is well to note that the ordinary telescopic fire escape on a wheeled carriage is, though primarily intended for life saving, a most important appliance also in aiding the work of extinction, by enabling the hose to be safely and conveniently worked at roof level or conveyed on to the roof itself. Long ladders of ordinary construction are springy and awkward to handle, and the safety and convenience of a proper telescopic escape are invaluable by comparison.

Great care should be taken, though, that only men who are taught the proper handling of an escape should be allowed to use it, as otherwise it is dangerous in unskilled hands.

Various compact and convenient fittings are to be obtained, consisting essentially of some form of pipe-bend and adjustable branch-pipe that can be attached to the head of an escape ladder, and take the heavy weight of the hose off the hands of a fireman stationed on the ladder, enabling him to direct a jet from any desirable level into the highest parts of a burning building. These fittings would, as a rule, only be supplied where there are standing fire brigades.

Fire-escape Shed.—In a fire-escape shed it will be found convenient to fit a cross piece or cross sling, so as to enable the ladders to lie

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balanced horizontally on their carriage ready to travel. (I allude to the modern "horizontal-running" escape now generally in use, having a special winding gear to elevate it, as well as a winch to extend the ladders). In Winchester Barracks a cross sling of wire rope was provided, with an outer covering of leather where the weight of the ladders came. An eye-splice was made at one end of the sling—dropping over a hook on the side wall—and thus capable of being easily cast off when the escape was run out.

First-floor Ladders.—The "first-floor ladder" is an ordinary and useful adjunct to an escape for use in enclosed courts and gardens; it is a short detachable length carried loose, but is, of course—as its name implies—only useful for a limited height.

Access to Buildings for Fire Escapes.—A most important matter for all who have to do with the fire protection of buildings is to consider the means of access to such high windows as overlook *closed courts and gardens.* Wherever possible, openings wide enough to admit the ordinary wheeled escape should be made, and a little forethought on this point may at any time prove to be the means of saving life. Many high buildings are partially surrounded by walled enclosures, and means of access for the fire escape is difficult or impossible. The openings may, if necessary for privacy, be closed with some light and easily removable palisading. At a notable hotel fire which I witnessed a few years ago the rescue work had been greatly hampered and some life lost in the earlier stages through the inaccessibility of high parts of the building from the above causes.

Where it is impossible to get this direct access, fire-resisting balconies should be provided leading to convenient points above the street, or in the case of rows of buildings, from the top windows of each to the nearest on the other side of a party wall. Recently, also—in the matter of the appliances themselves—specially light telescopic escapes are made, which can be detached from their carriage and carried into enclosed places.

Chemical Appliances.—Chemical "first-aid" appliances—known to firemen as "Kemik's"—have come much into favour in this country recently, but care should be taken to obtain only reliable makes and to ask expert advice, if possible, from practical firemen. Fatalities have occurred through the explosion of these machines. A good deal of discussion has taken place as to the value of the gases liberated in aiding the extinction of the fire, but whatever this may be, the primary use of the gas is to generate at once the necessary pressure; and many such machines are now worked by compressed air, contained in a small cylinder attached to the water tank, instead of by chemical action. One great thing to remember about this class of appliance is that it is soon exhausted, and if it has not by then extinguished the fire, other means should have become available on the spot to complete the work.

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Hose.—With the general introduction of canvas hose, the questions of thorough drying and careful handling become of the greatest importance. Every man who has to use it should know the right way of laying it down, with a view to the avoidance of that unnecessary dragging about which so quickly ruins the material.

Hose Reels and Hose Carts.—The hose reel is being now largely superseded in public practice by light hose carts, which enable the coils of the hose to be more readily examined and dried, but the reel enables the hose to be more quickly laid down by persons of little skill.

Tanned canvas hose is valuable in hot, damp climates as being less liable to decay.

A small but useful addition, which I have not always seen on W.D. hose reels, is a couple of straps or clips to enable a large T-headed hydrant key to be carried on the reel itself; otherwise the key may not be instantly available at the spot required, especially at night. Small gear has a great tendency to get separated and mislaid in the hurry of a fire alarm, and should always be kept on the machine to which it belongs.

Hose Couplings.—In ordering hose and connections I may remark that, with reference to the expression "brigade thread" or "brigade gauge," there are two gauges which are often so described; one is the *old* "brigade V-thread," the well-known sharp-edged thread in very general use, and introduced about 80 years ago by Mr. Braidwood; the other, the much larger round thread introduced later by Sir E. M. Shaw into the London Fire Brigade.*

Various kinds of instantaneous couplings (as R.E. officers will know) are now in extensive use. Details of screw couplings with their sizes are shown in the "Vocabulary of Stores" (Barrack and Hospital Services).

General Notes.

In concluding these remarks, I should wish to add a few words as to recent progress in the subject of fire appliances generally since a paper which I sent in in 1906.

The continued increase in the use of motor fire appliances is very notable, and cities and towns which have hitherto held aloof are now following the trend of affairs in this matter. The petrol motor engine (*i.e.*, a motor pump) seems likely in many places to rival the "steamer" in usefulness. It has the advantage over the self-propelled steamer that no expenditure is incurred for gas, or other heating, while standing. Also, having no funnel or boiler to take up space, long life-saving ladders can be carried overhead on the same vehicle as the pump.

* The official title "London Fire Brigade" has recently superseded that of "Metropolitan Fire Brigade," the forces of other chief cities in the Empire having adopted the latter title in some cases.

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The now well-known "Fire King" steam motor of Messrs Merryweather's design has done, and is doing in many places, since its introduction some six years ago, a vast amount of useful work. To remedy a difficulty that has arisen in some towns—the cost of gas for keeping the boiler always under a good pressure of steam—the makers have recently introduced a slow-combustion stationary boiler, with instantly detachable connections, that are made with the boiler of the motor while standing on duty in the station. A great saving is claimed by this system, and moreover no gas need be laid on to the station.

Where a competent engineer is kept permanently in charge, it seems not unlikely that the petrol motor pump may become the fire engine of the future in large town brigades, though the horsed steamer will probably always have a great field of usefulness in many places where the local resources do not allow much opportunity to the fire brigade for motor-driving practice on the roads.

It is to be observed that London and those of the large cities and towns which first adopted motor appliances are, as the result of their experiences, extending the use of motor traction and erecting stations where none but motor machines are kept.

It would appear that some form of the motor-driven and motor-propelled pump, such as the petrol fire pump just alluded to, might prove a valuable adjunct to the water-supply equipment of R.E. companies, particularly on account of its requiring no feed-water *en route*. A petrol motor fire engine from Glasgow is recently reported to have run 16 miles in 34 minutes to an out-district fire, and to have done good work on arrival, showing the great utility of this class of pump for travelling, without halts for feed-water.

A typical petrol fire appliance of the latest type (as adopted in London and other British cities) is driven by a 40–50 H.P. motor, and carries a 55′ telescopic escape, 1,000′ (or more) of canvas hose with hydrant connections, and a 40-gallon chemical (or compressed air) engine for small fires. Eight men can be accommodated on the vehicle, and a speed of 20 to 30 miles an hour obtained on the level. A petrol-driven pump may form a part of the machine also, but is more usually mounted on a separate vehicle, similar in power and speed to that just described, and doing the work of a steamer.

Comparison of petrol with steam machines in fire-brigade, as in other work, is difficult until long experience in practical results and expenses of working has been gained.

Alluding to the large chemical fire engines used by public brigades, the tendency is to adopt a *single* cylinder only. In the event of this not being found sufficient to overcome a fire, it will then generally be worth while to complete the work with a hydrant, in preference to the disadvantages of the weight and complication of having two chemical tanks capable of alternate action, as in some designs of chemical engine. Of course, where the water supply in the mains is

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exceptionally unreliable, the double-cylinder machine would have its special value.

For a certain and very common class of small fire, involving the cutting away of floors and woodwork, and an *intermittent* delivery of water as the burning parts are opened up in turn, the "Brigade" hand-pump still holds its own against chemical machines, which empty themselves in a few minutes, and it is well to remember this in considering the fire equipment of any buildings.

Some very interesting and comprehensive tests have recently been made—and the results published—by the British Fire Prevention Committee, giving comparative results of the working of small chemical and patent appliances and of the ordinary "Brigade" hand-pump and buckets. These tests should be carefully noted by any who are interested in the subject. The experiments tend to confirm the general experience gathered in practice, viz., that the various small chemical "extincteurs" and other patent "first-aid" devices, while very handy in many situations in checking a fire at its commencement, should be quickly supplemented by an ordinary water supply, so as to make a certainty of the job on which they may be engaged.

It must be remembered that public exhibitions of the many forms of fluid and "dry-powder" extincteurs are usually made *in the open*, and practically represent the effective use of these appliances on cases of fire suitable to their capacity. Many other cases of fire—such as occur daily *indoors*—will require other means to deal with them, since, owing to the heat and smoke, it will be impossible for the users of the patent appliances to get close enough to the seat of the fire. A "first-aid appliance" should, for this reason, be capable of throwing a *jet*—even if small—to some little distance, and not require too close an approach to the flames. The "personal element" also will always count for a great deal in using such apparatus. The coolest person may tend to become flurried when his own home and possessions are in danger, leading, probably, to a far less efficient and certain result than the professional operator—or skilled fireman, if he be called in—attains at any exhibition.

Nothing has yet been found more useful as an auxiliary to the ordinary bucket than the light hand-pump, throwing a good jet—small, no doubt, but strong and continuous. These are however only fitted to carry on the first attack on an ordinary small fire, or to tide over the interval that is required until full-powered engines or hydrants can join in the work should the fire prove serious.

Speaking of small gear generally, various improvements continue to be brought out; among such being a useful "spark deflector" for steam fire engines, enabling the stream of sparks from the funnel to be thrown in any given direction—an important precaution in crowded situations—when the engine may have to work very close to buildings.

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CAPTAINS SIR THOMAS ROTHERAM, KNT.,
AND
NICHOLAS PINNAR,
DIRECTORS-GENERAL OF FORTIFICATIONS IN IRELAND, 1617—1644.

By LIEUT. W. P. PAKENHAM-WALSH, R.E.

ON the death of Sir Josias Bodley in 1617 (see the *R.E. Journal* for October, 1908), Capts. Sir Thomas Rotheram, Knt., and Nicholas Pinnar, "being ancient servitors of good merit in Ireland, made humble suit to the King that the office lately held by Sir J. Bodley might be conferred upon them, on condition that the third part of the entertainment assigned to Sir Josias should from henceforth cease and be abated." This petition was granted, and their fee fixed at 10s. English a day for life.*

Of the antecedents of these two men little is known. Sir Thomas Rotheram apparently came to Ireland about the same time as Bodley (1598), and was recommended as "having deserved well in the wars, especially at Kinsale (1601–2)," where he served as a Captain of Foot. Subsequently his name appears as a Member of the Council of the Province of Connaught, and also as a member of several commissions.

Nicholas Pinnar came to Ireland in May, 1600, as a Captain of Foot in the army sent to Lough Foyle under Sir Henry Docwra. His company being disbanded on 31st March, 1604, he was assigned a pension of 4s. a day, and in 1610 he offered as a servitor, "not in pay," to take part in the Plantation of Ulster, and was allotted 1,000 acres in County Cavan in the following year. He did not however meet with success, and abandoned the project.†

In a "List of Concordatums as have to be paid out of the Treasure and Revenue between October 1st, 1617, and March 31st, 1618,"‡ there are the following entries :—

"4th February, 1617.—To Sir Thomas Rotherhame, Knt., for viewing Castles and forts of Monaghan, Moyerie, Mountjoie, and Charlemount, wherein he abided 20 days."

"10th March, 1617.—To Capt. Nich: Pynnar for employ[t] in the Provinces of Ulster and Connaught, to view the forts, etc."

* Privy Seal, Westminster, February 9th, 1617. R. 2. Patent, Dublin, February 27th, 1617. 15. 6a. pars. d. R. 4. The Irish £1 was only worth 16s. 8d. English.

† *Dictionary of National Biography.*

‡ Calendar of State Papers, Ireland, Vol. 234, p. 195.

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At this time a new office of "Master Carpenter" was instituted under the following patent* :—

"Whereas We think it convenient and necessary, as well for the reparation of Our castles and houses, as for the erecting of other buildings and works within this Our Kingdom of Ireland, that there be from henceforth constituted and appointed an Office of Master Carpenter, for Us, Our heirs and successors in that Our realm of Ireland, for the better erecting and finishing of the said works from time to time. Know ye, therefore, that by these presents We do constitute, ordain and erect an office or place of Master Carpenter, to be employed in all Our buildings and works in Ireland, the works belonging to Our office."

John Bannister was the first appointed to this office,† and the only other recorded holder of it was John Mills (vice Bannister, deceased) in 1661.‡

In 1618 Pinnar was appointed "Muster-Master" in Munster and Connaught,§ while on November 30th of that year there is a "Report of a survey of the number of acres in County Longford and Ely O'Carroll by Sir Thomas Rotheram, W. Parsons, Surveyor-General, and Nicholas Pynnor."‖ On November 28th, 1618, they were appointed Commissioners under the Great Seal of Ireland "to survey and to make a return of the proceedings and performances of conditions of the undertakers, servitors, and natives planted" in the six escheated counties of Armagh, Tyrone, Donegal, Cavan, Fermanagh, and Londonderry, on which work they were engaged till March 28th, 1619, and the report of which is in a MS. "Book of the Plantation of Ulster, by me, Nichollas Pynnar."¶ This was printed by Walter Harris in his *Hibernica, or some Antient Pieces relating to the History of Ireland*, in 1757, and again by the Rev. George Hill in his *Plantation of Ulster*. It is frequently referred to by subsequent writers and called "Pynnar's Survey," but a more valuable survey** was made three years later.

The following description of the fortifications of Londonderry is taken from "Pynnar's Survey," and there is also a lengthy description of Coleraine :—

"The City of Londonderry is now compassed about with a very strong wall, excellently made and neatly wrought, being all of good lime and stone, the circuit whereof is 284 perches and $\frac{2}{3}$, at 18 feet to the perch,

* 16. James I. 4a. pars. f. R. 42.
† Patent, January 15th, 1618.
‡ Patent, September 13th, 1661. 13. Ch. II. 5a. pars. f. R. 6.
§ Calendar of State Papers, Ireland, 1618, p. 227.
‖ *Ibid.* p. 218.
¶ *Carew Papers*, Vol. 643, p. 93, and Stearne MSS. F. I. 19. Trinity College, Dublin.
** Sloane MSS. 4756.

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besides the 4 gates which contain 84 feet, and in every place of the wall it is 24 feet high and six feet thick. The gates are all battlemented but to two of them there is no going up, so that they serve to no great use."

On November 3rd, 1621, the Lord Deputy and Council forwarded to the Privy Council an "Estimate from Capt. Nicholas Pynnar for what is needful for the repair of the fort near Galway," and "building 10 houses for soldiers and another house for certain officers"; also an estimate by Pinnar for the repair of the fortifications at Castle Park (Kinsale),* and again on December 5th "Capt. Pynnar's survey of repairs for the castle of Limerick, the forts of Galway, Duncannon, Halebowling, Castle Park, and Banaghor, and the petition of Malby Brabazon for the repair of Ballinasloe Castle with order thereon."†

On September 2nd, 1623, the Lord Deputy wrote from Chichester House concerning the ruinous state of the forts and castles, and enclosed an estimate by Pynnar for their repair amounting to £3,000, stating that if not repaired they had better be razed. The following extracts are taken from Pynnar's report‡ :—

"Repair of Forts.

"Note of money desired for the reparation of forts and castles to make them defensible against Irish rebels till a greater charge is bestowed to make them hold out against foreign invasion.

Leinster.—Mariborough, Phillipston, Leighlin, Wexford Castle.

Mounster.—Dungarvan Castle, in great decay, estimate £1,000, which is omitted by reason of the greatness of the charge.

Connaught.—Athlone Castle, for building and finishing the tower and scouring the ditches. The Sept of the Kellyes are bound yearly to allow to that Castle 300 men's labour. A castle to be built in the middest of the Curlewes, one mile and a half from the Abbey of Boyle. Also a fort and wooden bridge at Drumrussie (? Carrickdrumrusk) being a passage into the County Leitrim, and highway for all stealths from County Roscommon, in O'Rorke's Country and from the Brenny into Roscommon. Burrishowle, to strengthen.

Ulster.—Liffer, charge valued at £500 or £600 by Sir Jos. Bodley, has been bestowed upon it, which makes it defensible against Irish rebels; £200 was borrowed of money assigned to Sir Jos. for Munster works. Colrane and Carrickfergus Castles in great decay and walls of town to be repaired by inhabitants out of entertainment allowed them. Moyrie Castle, Mountnoris, to strengthen. Massarene, Castletone, Culmore, £600 or £700, but if the ward be removed to Greenecastle it is needless to bestow any more than £100 spent,

* Calendar of State Papers, Ireland Vol. 236, p. 339.
† *Ibid*, p. 340.
‡ *Ibid*, Vol. 237, p. 429.

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borrowed of money assigned for works in Munster; Greencastle fitter for a ward than Culmore, as may appear upon draught of establishment now sent. Dungannon,* to make it defensible against the Irish rebels; but if his Majesty shall be pleased to assign it as a seat for the President, and to the building of it will allow the next Easter and Michaelmas rents of Tirone, he will, with some help of the country, cause it to be built fit for the President, when his Majesty shall appoint one, which otherwise will cost his Majesty much more to build it. Castlenedoe, Donnegall, Eniskillin, Cloughouter, Dungevin, Enislaughlin, total £2,841 13s. 4d. sterling, and for a Castle on Longford side of the Shannon, £200. Omy Fort, when finished at £800 or £900 was brought to the perfection it is now at by Capt. Edmonde Leighe, now deceased, who bestowed on it, of his own proper goods, £500 sterling, whereof he has yet received but £100 paid out of the rents of Tirone, which he has left his wife to relieve her and satisfy divers debts that he owed by reason of that building.

No part of these sums is of the project formerly made by Sir Jos. Bodley for which there was money assigned."

On April 11th, 1624, the Lord Deputy sent to the Privy Council a "survey by Capt. Pynnar on the ruins of Dublin Castle, with an estimate," and desired directions for its repair.† In the same year Pinnar prepared some drawings of the rivers, forts, and castles of Ireland, which are still extant.‡

The following letter, from the Lord Deputy to the Privy Council, dated Dublin Castle, 10th March, 1624-5§, gives an insight into the delays and difficulties experienced, owing to the extreme centralization, which caused everything to be referred to London :—

"Having had a sight of a letter lately arrived to Lord Docwra, from the Council of War there, directing them to deliver to Sir Thos. Rotheram and Capt. Pinner £1,000 for the building of 3 new citadels at Waterford, Cork, and Galway, in each place one, and they to be the first works which should be begun, and the preparations to be made presently, and when his warrants of assistance were craved for taking up of carriages and materials he was in doubts what to do: 1st because he had received no information of it himself from the Privy Council that might be his sufficient warrant to appear. 2ndly because of the danger of disorder in the two towns of Cork and Waterford if they should be alarmed at these preparations for putting bridles in their mouths, having in former times given sufficient testimony of their impatience to submit to it, as may witness the not-to-be-forgotten violence wherewith Cork fell upon the new fort, then building to command them, when upon notice of the Queen's death, they fell furiously upon it and pulled it to the ground,

* Dungannon is in Tyrone, and is not the same as Duncannon, mentioned elsewhere, which is near Waterford.

† Calendar of State Papers, Ireland, Vol. 238, p. 479.

‡ Additional MSS. No. 24200, British Museum.

§ Calendar of State Papers, Ireland, Vol. 240, p. 569.

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notwithstanding that Tyrone was then overcome and the heart of the rebellion broken.

Upon these considerations he conceived it the safest course, to publish it for his intention to begin the fortifications with the repair of the fort of Halbowlinge, in the mouth of the River of Cork, and with the enlarging of the fort of Duncannon in the mouth of the River of W'ford (for he had already made sufficient preparations out of the poor portion of Concordatum monies) and under these two colours to lay in at the several towns their several preparations, and upon the arrival of the new companies with their supplies, to place in W'ford a garrison of 400 or 500 men and in Cork 300 or 400 more, to repress any resistance of the proceedings of the Engineers, for they might resist without these forces to contain them in their duties. The opinion of some of the Council here, being the best experienced men of war in this kingdom, agreeing with these views of his, he is resolved so to proceed and thus humbly presents it to their view.

Complains that being deprived of all power to do any man good by his own authority, here or there, by his recommendation, makes all men shun relation to him and dependency upon him. . . . Appeals to them whether it is not fit that the number and places of the new forts to be erected and the old to be repaired, being resolved upon there, it should not be remitted to them who are on the spot to choose which of them shall first be begun, which next, and which last. . . . Presses for more timely answers."

On April 5th, 1625, Sir Thomas Rotheram and Capt. Nicholas Pinnar, "Overseers of the Fortifications," reported from Waterford to the Lord Deputy, concerning the new citadel to be erected there, that "on arriving here we consulted with Sir George Flower and settled that the best place to build the fort was at St. Patrick's Gate where Capt. Yorke began one. Our Engineer, Capt. Noon, says that it is stronger than the citadel of Antwerp or Ghent. We can make the fort so that we pass through the town wall to go into it. Our arrangements will be to flank all the streets, and two or three of the towers will be brought into the work. A poor man, whose garden we are going to build over, should be compensated. We can begin our work at once as the town is all the King's and no one will withstand us." And again from Cork on April 11th that "in our last we forgot to mention the old fort across the river at Waterford. We inspected it but found nothing but the walls and a very rocky floor inside. The distance between this fort and Christ Church* is 323 yds., we took it with our instruments and did not differ a foot from Capt. Fredericks. We should advise that it be either strengthened, which would be expensive, or razed; for an enemy taking it would be able to bombard the town." To this there is a marginal note, presumably by the Lord Deputy—"Nothing to be

* The Cathedral of Waterford.

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done as yet, till Council of War decide, but new fort to be begun as suggested in their letter of April 5th, 1625."

Rotheram and Pinnar then proceed to deal with the fortifications of Cork, from which the following extract is taken. It is not clear who wrote the quaint marginal notes, presumably the Lord Deputy.

"We crave your attention to the following points :—

1. Does your Lordship require store houses and munition houses built? also lodgings for the soldiers. — *Such buildings are necessary to the fort.*

2. Do you think fit to make carriages for the ordnance? The guns are all dismounted. — *Peradventure these things can be done.*

3. Should the old shovels be taken out and used? — *Order shall be taken for these presently.*

4. Shall we rebuild the fort at the South side of the town on the way to Kinsale on the site of the former fort? It is a good position and the fort need not be so large as in the old times. — *This opinion well approved.*

5. The citizens have abused the fort, built houses in it, and made a lime kiln in it. But it is the King's land, as it was Church property and purchased by Queen Elizabeth. A warrant to us to seize the lime made in it, would be a great boon as lime is very dear here. — *They must smart for their presumption and bear the charge of mending the fort.*

6. If there is to be a second fort much the best place is the rock right before the North Gate, unless it be at Shandon Cast. which standeth most convenient and which Lord Barry will either let or sell. — *Council of War will decide this.*

7. We think the King's force should take the prison built over the North Gate. It was built by priests, but if manned by the townsmen it might keep the King's forces out of the town. As it is on the wall we conceive it belongs to the King."*

There is also a report by Capts. Pinnar and Noon that they "recommend the restoration of King John's Fort which has been partially demolished by the townspeople. For various reasons they consider the fort of Haulbowline of no purpose. It was intended to watch the outgoing trade, but the merchants of Cork now take their goods overland to Crosshaven, and so defraud the King of his customs. Men could not go to and from it if the weather were stormy whereas a garrison in the mainland fort could always be relieved and would only be seven miles from Kinsale." This new fort was estimated to

* *Conway Papers.*

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cost £1,200. No further trace of Capt. Noon has been found anywhere, but there can be no doubt from the above extracts that he was a military engineer regularly employed under the Directors-General of Fortifications. These reports were forwarded to the Council of War by the Lord Deputy on June 13th, 1625, and he wrote again in July "that his Commissioners find that there is an excellent spring in King John's Fort and wishes further orders for the construction of a fort on this site."

But the Government was now in serious financial difficulties and funds were not forthcoming, and on August 25th Pinnar reported from Waterford that "he has just returned from Cork where he has seen that the fortification is proceeding in a most satisfactory way. Nothing has been done that was not necessary, and expense has been much reduced by the use of the squared stones of the old forts. The work is very well forward and a 'portole' of stone finished. Mr. Piercie of Cork has lent him £130. He urges if money be landed, to forward it at once, as people are offering to lay £500 to £200 that the forts will never be finished."

The Lord Deputy complained further that "his power has been so much curtailed that people think he must get orders for everything from England."

Eventually sufficient money was raised to carry on the forts at Cork and Waterford, evidently by means of advances from public-spirited people, like Richard Boyle, the "great" Earl of Cork, who sent the following letter to the Lord Deputy (Falkland), dated May 8th, 1626, who forwarded it to the Privy Council in England on the 11th of the same month:—"I regret your inability to send me money. The half built forts have already suffered much during the past winter. I told your messenger, Capt. Pinner, that rather than see them unfinished I would pawn all my vessel and plate and furnish £500 to bring them to perfection. I am now ready to do this, but as your Lordship knows, I have already spent £500 for the land forces, and this not out of any plentiful estate or store of Money, but will give Capt. Pinner £20 a week till I hear from you. He thinks £500 will be enough to furnish the forts, though not the storehouses in reasonable time. I must ask such security as Lord Brabazon had when he supplied the army, otherwise I must be excused from paying. The Counties of Cork and Waterford are ready enough to contribute, but the other Counties not so." The idea of private individuals pawning their plate in order to get the fortifications finished sounds quaint nowadays, and even Rotheram and Pinnar, as will be seen later, appear to have advanced money in order to get the work done. Accordingly Lord Deputy Falkland was able to report on September 4th, 1626, to the Privy Council in England that "the forts at Waterford and Cork are now fairly tenable. I send Capt. Pinner, who has worked well at them, to tell

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you what more is wanting for them. I have made him Quartermaster of the Army and hope he may be placed on the new Establishment."

Pinnar accordingly made the following report, dated December 26th, 1626, to the Council of War :—

"I have delivered accounts of the money I have spent on the two forts of Cork and Waterford. The £3,840 I received from Lord Docwra and £500 besides lent by Lord Cork have been spent on them. I have also myself spent £120 on building materials which are ready in the fort in case any occasion arises for their use. If they are not used I shall ask leave to sell them as I bought them at your Lordships' entreaty. The Cork fort is 30 feet high facing the town and elsewhere 20 and 16, all of good lime and stone. The foundation is 10 feet thick and often more and the top of the wall is 6 foot thick where the parapet must be placed. The rampart is 20 feet thick but requires more earth. There is only a wooden blockhouse inside where soldiers keep guard and watch, a gate with no roof, and a secret port in the ramparts for keeping ammunition. I left ten barrels of powder in it and bullets answerable. There are ten guns mounted towards the city. Waterford is also ready to the placing of the parapet. It has a good foundation on flat rock and is well built. The gate is of hewn stone, and there is a good lodging in it with a chimney covered with slate. The wall is of 6 feet of stone and 25 feet of earth and the bulwarks (*i.e.* bastions) filled with earth to the height where the ordnance must be placed. I have made a well, put up the frame of a stone and lime house that will lodge 120 men and taken into the fort three castles of the town walls of which I have roofed two. I have floored three rooms in one and use another for a storehouse, whilst the third (? the roofless one ! !) is a lodging for the officers. I have mounted some guns on a wooden platform and they overlook the town, but there is no moat dug for want of money. I enclose plans."*

Meanwhile Sir Thomas Rotheram was engaged in building the fort at Galway (of which town he was Captain and Governor), and wrote to the Earl of Clanricarde on March 7th, 1626, that "my long silence is not due to want of respect, but to the fact that I have for many years been a stranger to Ireland and Connaught.† Last summer I was employed to build a fort on the west side of the town of Galway, which, by the opinion of experts, has been placed outside the wall, near the bridge. I had also orders to build some houses and make additions to the old fort. I have spent £1,450 in 3 months on the two and have done good work at the price for his Majesty. I paid £200 of my own to forward the work of which two parts only have been repaid. Neither fort is now tenable. The forts at Carrick and Waterford are being continued, but mine I fear will remain unfinished. They are important however and the Artillery should

* These plans are unfortunately now missing.

† From this it may be inferred that Rotheram was out of Ireland between 1619 and 1625.

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be mounted. The Mayor and Corporation of Galway have written to the Lord Deputy to beg that the work may be finished." He wrote again on January 12th, 1627, that "the old fort at Galway must be better fortified if it is to be held. Spent last summer in Galway and saw the soldiers mutinous for want of food and clothes. Did not like to punish them severely and did not know if he had power to do so." He again called attention to the weakness of the Galway forts on June 8th of the same year.

At this time there is a draft containing a list of sums due to various officers, including Sir Thomas Rotheram and "Capt. Nichols" (Pynnar) (*sic*) "Overseers of the Fortifications."

In 1630 Pinnar went to England as the bearer of a letter from Lord Wilmot, Commander-in-Chief, to Lord Dorchester; and he also had a letter of recommendation from Sir William Parsons, Surveyor-General. Lord Wilmot's letter is dated from Dublin, April 22nd, 1630, and recommends "Capt. Pinner, the bearer, who has done much good to the forts in Ireland. Although holding a pension on the establishment by patent under the broad seal he was left out of the last establishment. He tells me he knew you well when you were ambassador at Venice. At any rate I beg you to right him." Lord Wilmot continues that "the ordnance of the country is in a wretched condition. Frequently the guns have no gunner allowed to them and we have no carriages or ammunition. The forts had better be demolished than stand so poorly guarded. I am indeed General of an Army by the King's favour, yet have no power to deal with these grievances."

In 1634 Sir Thomas Rotheram resigned his office, and the only subsequent reference to him is in 1641 in a list of "several of His Majesty's Privy Council in Ireland who may lend money," with £500 against his name. The Crown was getting shorter than ever of money.

The office of Director-General of Fortifications was re-granted for life to Capt. Nicholas Pinnar from 13th September, 1634, with a fee of 5s. English a day.* "The fee of 10/- a day being omitted out of y^e^ Estab^t^ commencing 10th April, 1633, an arrear occurred for 10½ years amounting to £1916-10-0 which being compounded by them for £958-5-0, so also a new grant of y^e^ office might be made to Capt. Pinnar with 5/- sterling a day. The King directed the same to be paid and granted."† This looks like a case of taking what you can get and being thankful!

From this date there is little reference to either Pinnar or the fortifications in Ireland. Presumably the Crown had neither time nor money to spend on these things, and was completely occupied with the impending struggle with the Parliament.

* Patent, November 18th, 1634. 10. Ch. I. 1a. pars. d. R. 19.
† Westminster, 12th April, 1634. 10. 2a. pars. d. R. 12.

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Sir William Parsons, the Surveyor-General, who had become one of the Lords Justices* in 1641, the year the great rebellion commenced in Ireland, fell from power and was removed from all his offices on 31st March, 1643; and there can be no doubt that Pinnar succeeded him as Surveyor-General, though no definite appointment has been traced. Pinnar died apparently in 1644, for his office was granted provisionally in November of that year by the Marquis of Ormond,† Lord Lieutenant of Ireland, to Capt. (or Colonel) John Payne. At the Restoration of Charles II. the office of "Overseer Director and Surveyor-General of all the Buildings, Fortifications, Plantations, Highways, Bridges, Fords and Passages in Ireland," vacant by the death of Capt. Nicholas Pinner, was granted to Capts. John Payne and John Hullam jointly,‡ thus making it clear that Pinnar had held the office of Surveyor-General; and from this date the office of Surveyor-General was coupled with that of Chief Engineer until the former office was abolished in 1762, when its duties were delegated to the Barrack Board.§

* The Lords Justices General of Ireland are not necessarily Judges. They are Commissioners, usually three or four in number, who perform the office of Lord Deputy (who no longer exists) when the Lord Lieutenant is absent from Ireland.

† Afterwards the "Great" Duke of Ormond.

‡ Privy Seal, Whitehall, February 6th, 1660. Patent, Dublin, April 26th, 1661.

§ Privy Seal, St. James', August 11th, 1762. R. 13. Patent, September 29th, 1762. 2 Geo. III. 3a. pars. d. R. 15.

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TRANSCRIPTS.

THE MILITARY USES OF SEARCHLIGHTS.

THE following is a *précis* of the above interesting work by Capt. Aggermann, which is published by Messrs. L. W. Slidel & Sohn, and printed by Franz Kreisel, Vienna.

INTRODUCTION.

Situations often arise in war time which lead to night operations, and as a rule they are directed against an opponent who has taken up a prepared position. The attacker will take advantage of the night to approach near the position, and prepare for the intended attack in the early morning or for a close pursuit of his opponent by night, so as to rout him. Night fighting may also arise in the continuation of an attack begun by day. If an attack by day—on account of the heavy losses which may be expected—appears to serve no immediate end, it may probably succeed if carried out by night.

Especially in fortress warfare the different means for preparing to attack by day must be carried out by night, so that they may be concealed from the view of the defenders, and so that every available hour may be utilized.

It is evident that such kinds of night operations can be interrupted and disturbed if the threatened force succeeds in detecting them at the right time, and electric lights are used in the first line to attain this object.

It is of course possible to conceive that lights will have their value in field operations, but they will play their principal *rôle* only in wars of position and especially in fortress warfare. For field work, lights will only reach some degree of importance when the weight of the carriages can be considerably lessened and teams of horses done away with.

The chief task of electric lights consists in illuminating the foreground for long distances, in order to detect, at the right time, every kind of hostile operation which is taking place within the range of the light. This detection then forms part of the service of reconnaissance, or allows an immediate opening of fire on targets which have been previously located. Besides this chief *rôle* the electrical apparatus can be otherwise utilized, but then the projector would be of no use. We do not intend to treat here with such side issues.

The searchlight is not an independent weapon, and, indeed, if it is to be effective it must be accurately laid on the target, so that it may be possible to either injure it, or, still better, to stop it or to put it out of action. Its chief *rôle* is to be found in the illumination of objects otherwise invisible at night, so that they may be energetically combated, and with the

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aid of searchlights it is possible to hinder and impede various kinds of night operations of one's opponent, to deprive him of moral, and to upset his plans.

It follows therefore that the searchlight belongs to night operations, in that it affords a prominent "aid" in time of war for long-distance gun-fire as well as for close range work. The effective range of the beam should agree with the most effective range for rifle fire at night, and for this searchlights of small diameter will suffice. We must endeavour to obtain a greater range for the light than the rifle, so that the approaching enemy can be viewed before he gets to within effective rifle range, and then the rifle fire can be begun at the most favourable moment. A rifle, for example, with an effective range of 1,100 yards, does not need a searchlight of 3 miles range—one of 1,600 yards would suffice.

PART I.

Part I. starts with a description of the different means by which the necessary electric arc, the source of light, is produced. The dynamo or accumulators, cables and the engine (steam, petrol, paraffin), are described. In the Austrian Army a distinction is made—in the portable application of searchlight apparatus—between the siege corps and the field army. They have also fixed apparatus in fortresses. Each portable set, with its *personnel* and teams, forms the tactical unit, "the Searchlight Section," called after the diameter of the projector.

ORGANIZATION.

One 90-cm. section consists of a 6-horse generator wagon (5,280 lbs. weight), a 4-horse store wagon (3,740 lbs.), and a 4-horse projector wagon (3,520 lbs.).

The *personnel* consists of—

One generator attendant and his assistant	2
One projector attendant with assistant	2
One observer	1
Three telephone men	3
One layer and the non-commissioned officer in charge ...	2
	10

One mounted non-commissioned officer and a driver for each pair of horses.

(*a*). *The Source of Light.*—Minute description of the arc, how produced, distribution of light, temperature, how kept steady, etc., and the automatic regulation of the lamp described.

(*b*). *Carbons* (*Horizontal Lamp*).—These must be very good and of new manufacture; their size, position in the lamp, control, care in burning, etc., are gone into.

(*c*). *The Reflector.*—Function, form, etc.

The silver coating is protected from injury behind by a layer of paper specially prepared. Should be mounted in spring clips.

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(*d*). *Distribution of the Light and the Amount of Illumination.*—Butterfly diagram described. Glass absorbs 10 per cent.

(*e*). *Testing of the Reflector.*—A candle at the centre should produce a perfectly even and round reflection. Tests with squared wire netting described.

(*f*). *General Construction of the Projector.*—Cylindrical body, etc., described. Provided with shutter dispersing lens, observation holes, ventilation doors, arc observer, carbon-holder adjusters, motors for traversing, etc.

Directing Details.—The advantages of motor traversing are that the observer himself can direct the light and observe at will. On the other hand the constant attention is tiring, and the uniform speed of traversing is also a disadvantage. For land work therefore it should only be used as the exception.

The advantage of hand-working lies in the possibility of illuminating any particular spot by a sudden movement, the rate being dependent on the gearing fitted. The great disadvantage is having to communicate your intentions to the traverser by telephone, which results in delays, inaccuracies, and misunderstandings.

Graduated circles with pointers also assist observation when using them with guns.

The dousing arrangements (signalling shutter or diaphragm) are also most useful when searching ground.

The double disperser is most useful for close work, but absorbs a lot of light, is heavy and expensive, but tactically sometimes indispensable.

(*g*). *The Cone (Beam) of Light.*—Although it appears as a sharply defined cone, many stray rays are reflected from the air and earth, and cause diffused light. Relation of beam to illuminated area is discussed.

The Range is defined as the average distance at which a practised observer under all ordinary circumstances, and from near the projector, can with certainty recognize field (warlike targets) objects, using, if necessary, field glasses.

Aids to Observation.

The best night glasses are very necessary, and should be used to recognize ground formations, hostile detachments, and for general observation. The telescope is also useful for distinguishing more detail. The eyes must be well protected from any outside light (from lanterns, the moon, or the searchlight); this can be very easily done by laying the thumbs against the outside corners of the eyes. Eyes must occasionally be rested by closing them, etc. It is very necessary to have reliefs, as so much depends on detecting the right target at the right time, and constant observation is very exhausting.

Means of Communication.

Telephones, if absolutely reliable, would suffice, but as they are not always to be trusted, other means, such as speaking tubes, megaphone, buzzer, whistle, lamp signalling or orderlies, must be used.

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AIDS TO SIGHTING.

It is most necessary to know the terrain; time must be allowed for careful reconnoitring of the ground. The tactical value of the ground must be studied with the aid of a map, having regard to the defender's positions and method of fighting, etc. The foreground to be illuminated should be settled and put on a tracing of the map. Then such objects as woods, tree clumps, houses, etc., which would come in the beam, must be identified and put on the map. Objects beyond the searchlight range should be marked and tabulated; objects throwing shadows may have to be cleared.

DISTRIBUTION OF THE GEAR WHEN IN ACTION.

Four groups are necessary—(1), The engine group; (2), one or more searchlights; (3), one or more observation posts; (4), horse teams.

The *personnel* required besides the mounted officer and orderly are:—

1 non-commissioned officer in general charge.
2 searchlight attendants.
1 observer.
2 telephone men.
2 engine attendants.

With small lights the attendant is the observer. All the numbers should be armed with rifles, and the duties of each can be framed as regular orders. When considering the cover for the engine, care must be taken that the exact and most effective site for the projector is in no way interfered with. If necessary, artificial cover should be provided and constructed before coming into action. It is most important that protection should be provided for the engine wagon.

SITE FOR THE PROJECTOR.

There is no difference tactically in the best sites for semi-permanent or for field searchlights. The following qualifications are necessary:—

(1). Unimpeded view over the selected section of ground to be illuminated.
(2). No obstruction to one's own fighting forces.
(3). Easy means of access to and egress from the site.
(4). Protection against hostile fire.

As regards (1). This necessitates height of position and flat open foreground, which is not often to be found. The greatest care is therefore to be taken to find the most favourable spot. Clearing where necessary must be carried out. The height of a position tends to shorten shadows and to decrease the extent of unilluminated areas due to undulations in the ground. This height must be provided artificially if not otherwise available, *i.e.*, by erecting towers.

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As regards (2):—

(*a*). The beam may unintentionally come in between the rifles and their targets and hinder their view.

(*b*). The beam may increase the difficulty or make it impossible to "lay" the guns owing to its dazzling or screening effect.

(*c*). A light, owing to its position, may mask the fire of a gun or be right in its way.

(*a*) Is caused by giving the searchlight too extended an arc, so that it flanks our own works. This can only be overcome by having several searchlights or by using dispersing lenses. The searchlight must be used directly to its front, and be allotted small sections of foreground only.

(*b*) Is caused by the light being too near a battery, so that either the layer has to look through too much of the beam, making the target indistinct, or the glare may be turned on the sights. To be directly above or underneath and in a line with the direction of the beam is no disadvantage.

(*c*) Is caused by the light being too far beyond the target, generally on one of its flanks, and so masking the guns. This can only be avoided by moving the searchlight, or by relying on smaller ones held in readiness in protected positions within the work.

As regards (3). It is very necessary to have a covered approach, and for permanent works rails are advisable.

As regards (4). The immediate foreground should be unfavourable for bursting shells, *i.e.*, without stones, etc.; not hard, but soft and uneven. Explosions are least dangerous when there is a steep high wall or bank immediately in front of the projector, in which splinters can bury themselves. Searchlights should not be installed in small and weakly constructed works. As the searchlight cannot be used indirectly (except by using plain mirrors to reflect the beam), it is obvious that it must be exposed, and so its keynote is "*First effect, then cover.*"

Projector Position (The Emplacement).

This is described from a permanent point of view. The open emplacement should be used as a rule, and the searchlight on a wagon brought up from the depôt when required. Sometimes a vertical pit is made and the projector mounted on a platform capable of being raised or lowered as required.

The Observation Post.

The observer should be able to see everything which comes into the illuminated field of the searchlight. The further he gets from the projector, the more does the field of view differ from that as seen from the projector itself. As he approaches nearer the projector, the field of view becomes again similar, but the observing less favourable. This is explained in that the observer has to look through more and more of the beam.

With small-sized projectors and at short ranges this disadvantage is not so noticeable. For controlling the projector a close connection

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between projector and observer is necessary (with small projectors the controller is also the observer). The most sure way is by shouting or using a speaking tube. For observation it is really best to be directly below or over the centre line of the projector. The observer must be careful not to be dazzled in any way either by his own or other searchlights. For long-distance observation an advanced position is necessary, the projector being directed by lamp signals; other means of communication are too liable to errors and interruptions, and take too long to prepare.

The post must be protected from the enemy's fire, and must be large enough to hold three people, with room to lay out the maps, etc. It must be connected by a covered way with the engine station and projectors. In permanent works all this would be included in the original design and protected by armour plating. With portable apparatus the best means attainable must be employed, and should follow that provided for the battery observers.

For one night the simplest preparations should suffice.

The Lighted Area.

The nature of the ground has a great influence on the extent of the illumination. It may be—

(1). Perfectly open and flat, passable everywhere.
(2). Even but undulating, with high-standing crops, copses and woods, with few cross tracks, but generally passable.
(3). Hilly; otherwise as in (1).
(4). Hilly; otherwise as in (2).
(5). Country as in (1) and (2), but besides intersected by streams and little valleys, so that moving troops are obliged to keep to distinct crossings and paths.
(6). Small mountainous country with steep and difficult or impassable tracks, and along the valley bottom one main L. of C. and the necessary side tracks.

Comparative Value of the Illuminated Areas.

(1) Affords an open and distant view, numerous positions, fields, open spaces, etc., where an enemy can easily be detected. But the searchlight must not be given too large an area to watch.

(2). A restricted view; few points where the enemy may be detected, an unfavourable terrain making the disclosing of moving objects very difficult.

In (3) observation is simplified, because the number of places where an enemy may appear is lessened.

(4) and (5). This ground is more advantageous for detecting objects than (2), and on account of the few favourable positions for the enemy, success is unquestionable.

(6). This ground is easily commanded, and as a rule it is not difficult to discover the enemy.

In all cases the searchlights must of course be sited as high as possible.

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Preparation of the Lighted Area.

At times it is necessary to prepare the ground by clearing trees, etc., and increasing the number of open spaces. In thick country large lights are of little use, several small ones being required instead. Clearing should be done for 800 yards to the front.

View and Observation.

It is not easy to see and to observe with searchlights. The inexperienced are apt to be deceived as to their utility, but those who have had practice know their value in time of war.

It is not wise to overrate their capabilities, nor to expect them to perform more than could be done in daylight. We must remember that only $\frac{1}{140}$ of the perimeter in an all-round view is illuminated by the beam. View and observation are influenced by—

(1). The nature of the beam, its intensity and form.
(2). Degree of training in the detachment.
(3). Practice of the observer.
(4). Choice of observation post and search-light site.
(5). Range of view.
(6). Ground formation, colours, shades, the objects themselves.
(7). Effect of the hostile counter-lights.
(8). State of the atmosphere or influence of the moon.

Of these (5) depends on whether the observer is in an advanced position or not.

As regards (6). Objects throw long shadows, and if naturally conspicuous and light coloured, appear, when lit up, much nearer than they really are. Dark objects, when green, reflect few rays of light, and are difficult to make out; they appear further off than they probably are. Hedges and copses cut off the light, and the thinnest mask conceals objects behind it at long ranges. A high site increases the angle of depression and shadows are shortened; where this is not possible we must be contented to use small searchlights at short ranges. Light blue-grey uniforms are most difficult to detect, especially when the background is green fields. The face and hands and arms of a man are the first detected. Detachments in open order, owing to their shadows, often appear double the number they really are. Weapons, tools, helmets, reflect the light and are seen at once. On the other hand, lantern lights, fires, etc., are not very visible when in the beam. Moving objects are more easily detected than those at rest. Sheep's eyes glow like lanterns.

As regards (7). Hostile lights, in their counter-effect, come next to the hostile gunfire in importance. By throwing one beam across another, the latter in its effect is interfered with, and an observer's view is very

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much impeded when an opposing light shines right on him. The beam of greatest intensity is the first to nullify the effect of its opponent. If a hostile beam shines directly up the line of one's own beam, observation is almost impossible. A screen may be used as a protection to dazzling. Artificially-created clouds of smoke impede vision. Other artificial screens are as a rule impracticable, as they would soon be detected by the enemy.

As regards (8). The atmosphere has a great influence; a dark, clear, dry night with no wind is most favourable to observation. The moon has a disturbing effect, especially if right in front of the observer. Damp air and fine rain are worse than large raindrops or snowflakes. Fog makes the beam useless. Smoke clouds show up brightly, but let no rays of light through. Strong winds make the arc unsteady. With glasses and no counter-influences, it is possible with a 90 cm. to pick up single men at rest at 1,700 yards, numbers of men at 2,200 yards, large bodies at rest at 3,300 yards. Aim can only be taken at a searchlight from outside the beam. It is not easy to hit a projector, and serious harm can only be done when the lamp mechanism is damaged.

Influence of Search Lights on Living Objects.

Observation is affected most when the beam shines directly in one's own eyes. It is of course impossible to look straight at the mirror from near at hand without protecting glasses. When not directly in the beam, the forward movements of any bodies of troops may be hindered by switching the beam to and fro, or by alternative exposure and dousing of the light, or by working it intermittently. This must be properly carried out by exposing on to the target, leaving the beam there until the opponents' eyes have got accustomed to the light, and then suddenly shutting it off. Mounted troops and teams are of course more easily disorganized than dismounted troops. The construction of fieldworks and the like must be suspended, because it is either dangerous to use the tools or else the work is impossible.

The Support of One's Own Troops.

It is possible to screen one's own troops or works by interposing one or more beams between them and the opponent. The beams in this case must remain stationary or work within definite limits, or else they may show up our own troops. This screening is as a rule only possihle when the foreground is quite level. In hilly country it is not possible, because the enemy's search lights can easily search above or below one's own beams; and further, lights which it is desired to use as screens must be at least as strong as the opponents. The searchlight may also assist by illuminating the line of march or by lighting up the directing point. It may be used in conjunction with reconnaissance by night or to signal with. Artillery fire can be carried out almost as accurately by night as by day.

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PART III.

Handling of the Projector.

The method of controlling the projector depends on—

(1). The construction of the searchlight.
(2). The kind of communication between the observer and the searchlight.
(3). The size of the projector.
(4). The formation of the ground.
(5). The extent of ground to be watched.
And (6). Many other different circumstances.

As regards (1). Whether automatic or hand lamp, motor traversing or hand. Double dispersing lens or shutter.

As regards (2). Whether by telephones or shouting or signalling.

As regards (3). Whether small, medium, or large size.

As regards (4). Open flat country and projector on a height; or close country, low-sited projector; or hilly country.

As regards (5). Arc of observer over or under 90°.

As regards (6); the other different circumstances are badly focussed beam, bad carbons, unsteady arc, bad reflector, poor aids to observation, loss in power, etc.

Personnel.

When using a 90-cm. searchlight with no double dispersing lens and no shutter; with automatic lamp, motor control, flat foreground, communication by call, and in a fixed position an attendant is hardly necessary, except once every three hours to change carbons. We rarely however have such a case, because most searchlights must be provided with "dousing arrangements." Double lenses too are necessary for siege work, and especially on the coast. The automatic lamps sometimes go wrong. Most field searchlights have no motor control and communication is by telephone.

Ground so flat as to afford no cover to moving objects can be systematically searched. It is advisable, if a searchlight has been brought late into action, to first of all search the nearest ground, otherwise the searching is done at the longer ranges first. For this method of searching motor control is a great advantage. One attendant is sufficient in this case (*i.e.*, when using no shutter or disperser).

Where it is required to watch a large area and to suddenly traverse the projector from one edge of the boundary to the other, hand control is necessary. Two attendants and a telephonist are necessary too. When the country is "close" or it is only required to watch a particular spot (if a bridge or dam), the horizontal range of traversing is small and electric motors will suffice. Local circumstances determine whether double lenses and shutters are necessary, and their use also depends on the number of men available. Particular methods for searching work must be practised. The beam must come on the opponent as a surprise, not giving him time to hide. This can be done by traversing the projector

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"doused" on to the particular area according to the corresponding mark on the horizontal scale, and then by suddenly exposing it. This requires some previous preparation to ensure success, by numbering selected points on the map and noting the corresponding readings on the projected scales (vertical or horizontal).

Carbons should always be allowed to burn for a short time before exposing. The observer then merely gives the number of the point to the light numbers, these traverse the searchlight on to the selected piece of ground and also adjust the elevation if necessary; the observer is notified that all is ready, and when he has adjusted his telescope or glasses, he gives "light" and the shutter is opened. In this case two men and one telephonist are necessary besides the lamp attendant. If the intermediate ground is open, the searchlight may be traversed quickly by hand, and without being doused every time, on to the selected spots. This admits of much quicker searching. It is clear that in this case no electric "controller" can be used, and that the *personnel* are severely tried and will want relieving pretty often. Dispersed beams are of great use at close ranges (about 880 yards), especially where it is possible for an opponent to "surprise" during the night. They must be kept exposed the whole night, and this is very necessary when the enemy has begun his siege works within range of the lights. In this connection it must be observed that constant observation is a very tiring thing, and objects may be missed which should ordinarily be detected.

Small calibre searchlights are light in weight and can be freely directed by hand. One man is sufficient to direct and observe up to 700 yards; beyond this range a special observer is necessary with night glasses. For the successful employment of searchlights it is necessary that—

(1). The observer should have a large amount of practice in the discovery and detection of objects in the beam of a searchlight.
(2). He must have a general knowledge of, and a good eye for country, and especially for the details of the illuminated area.
(3). The searchlight must be expertly handled, *i.e.*, the *personnel* must be highly trained.
(4). The available material be intelligently distributed and sited.

As regards knowledge of the ground and with special reference to the distribution of the material, the searchlight officer (*i.e.*, the observer) must be on the ground at least two hours before nightfall, so that the ground to be illuminated may become impressed on his mind as viewed from his post, and so that he can make a simple eye-sketch of it. Unless he does this he cannot expect to have any definite success. If time and the situation allows, he should examine for himself and make a reconnaissance of the foreground.

The General Employment of Searchlight Gear.

To the defender of a fortress searchlights are indispensable. They are not so necessary to the attacker. Along a coast line where landing is favourable, small calibre searchlights are wanted, and should be used in large numbers.

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In frontier (mountain) forts the size of projectors depends on the formation of the ground and the task required of them. Fixed equipment should only be used in permanently constructed works, otherwise mobile equipment should be employed unless there are reasons against it.

In field operations the value of searchlights, especially small ones, is only evident in a position intended to be stubbornly defended, but in such cases they are of very great use.

Other uses are to be found—

(1). In the illumination for working parties of all kinds.
(2). During construction of batteries at night.
(3). In the lighting of enclosed spaces, parks, and yards.
(4). Searching for the wounded after an engagement.

The effective range of rifle fire at night may be taken at 1,100 yards to 800 yards, and a searchlight of 70° dispersion covers at this distance a front of 1,300 yards, *i.e.*, the front of one brigade; under this 800 yards small searchlights are necessary. From this we can determine that at least six large searchlights are required for an infantry division. Choice of calibre depends on the ground formation; generally in a unit one-third should be 90 cms. and two-thirds 35 cms. or 45 cms.

In fortress warfare long-distance lights are of undoubted value to the attack, and for the defenders they are also indispensable, and should be augmented by those of small calibre and in large numbers.

When a fortified place has been successfully surrounded, the attackers are still a great way off, but as the siege progresses they get nearer and nearer. If after the defender has been driven out of his advanced positions he wishes to gain some knowledge of the enemy's forward movements at night, he must be provided with long-range searchlights.

Parks, depôts, batteries, and the like are hidden from view or are too far off to be illuminated, and the lights are, therefore, chiefly needed for observation and attack of movable targets and should be easily traversed as well as being very powerful. For this purpose the medium-sized one of 90 cms. is evidently better than the very large and heavy one (*i.e.*, 120 cms., as used on the coast).

To assist in warding off the attack, the small searchlights are necessary; but the larger ones, being used from retired positions, can in conjunction with them afford some assistance in the defence of the advanced works.

As the defenders are driven back within the girdle of forts, these large-sized searchlights may be used both to illuminate siege batteries, depôts, fields, railways, and shelters for material, and to disclose protecting parties, concentration of troops, night marches, etc., and also they may be used to screen sorties made by the defender. The attacker will use his lights to hinder and baulk the working of his opponent's searchlights, to screen his own operations, and to assist the night firing of his own batteries. The defender must avoid bringing his lights too soon into action, so that they may come as a surprise to the enemy.

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THE EMPLOYMENT OF SEVERAL SEARCHLIGHTS.

When using several searchlights they must be carefully allotted for watching particular sections of foreground; otherwise beams crossing and intersecting each other will make observing almost impossible. With several searchlights it is possible

(*a*). To illuminate a large fixed area.
(*b*). To increase the visibility of an object by superimposing beams.
(*c*). To keep a few "doused" and to always have some in reserve.
(*d*). To allot some for signalling purposes.

It is useless—and in fact hardly practicable—to concentrate several searchlight sections under one commanding officer. Each searchlight section officer is responsible for obtaining the "most" out of his light, and should be directly under the nearest tactical commanding officer.

The chief *rôle* of searchlights then is to search the foreground for hostile objects, and to so light up these targets that fire can be brought to bear on them.

For long distances, guns are used, for short distances—rifle fire. Guns and searchlights must always work together.

As a rule the long-range projectors are put under the Officer Commanding the Artillery, who is responsible for informing the searchlight officer of what he wants done, and it is the business of the latter to arrange how the order should be carried out.

Besides this however it is the searchlight officer's duty to so handle his lights, that no opponent can approach unobserved. In this matter he is to be considered the specialist. He should be in telephonic communication with the Officer Commanding the Artillery. The actual directing of the search light should never be taken out of the hands of the searchlight officer by the battery commanding officer.

In determining the number of searchlights for any particular situation, such as the defence of a fortified camp, as much of the foreground as possible should be illuminated by long-range searchlights, while the dark intervals are lit by the small ones. Some, too, must always remain in reserve, and two or three sets (portable) must be ready for moving from place to place.

As a rule it is advisable not to expose the searchlights until all one's own troops have finished the reconnaissance work to the front and have withdrawn within the defence line.

The searchlight officer must be kept informed

(1). Of the enemy's situation just before it gets dark.
(2). Of our own situation and any intended night operations.
(3). What terrain is to be illuminated and what are the main points to be watched.
(4). Where the neighbouring searchlights are sited.
(5). Of the general field of fire of the guns.
(6). What time to expose his lights.
(7). The proposed method of "combination" amongst the lights.

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(8). Where any information is to be sent or orders are to be obtained.
(9). What the escort is and where situated.
(10). The likely length of the run.
(11). Procedure when bombarded or assaulted.
(12). Ways of retreat.

PORTABLE GEAR.

Duties of the Searchlight Officer before starting the Run.—Having received orders from the tactical commanding officer for the occupation of a certain position, he first examines the position, and studies the map. He then chooses the actual sites for the lights, and for the engines and teams, having regard to the situation on both sides and to the nature of the ground, etc. He notes what measures should be taken for the artificial defence of his lights and detachments. He judges whether he wants extra aid from the working parties. Whether it is essential to build cover, and if it is to be done by night or day. He must then make a very careful study of the section of ground to be illuminated from the actual projector site. He should make an eye-sketch for his own personal use, containing chiefly information which is not on the ordinary map, but which is very important for night work and observation.

This sketch should contain therefore some prominent distant points, all the visible roads and portions of paths, fields with high crops, stone walls, and road crossings, etc. The map need not be to scale, but all important objects should be numbered consecutively. These should be put down in a table and shortly described. He must select sites for the reserve lights and observers, in case of a necessary change of position. He must then give instructions to his relief, to the observer, the projector numbers, etc., and see that the latter know very decidedly the number of their position. About 1½ hours before dark the gear should be brought up and installed. The engine numbers make all necessary preparations. Just before dark the projector and observing parties go at once to their places, having in the meantime laid out the cables, telephone lines, etc. When night comes on everything must be ready and the light started with the shutters closed; instructions must be given to all concerned as to the way the work of searching the foreground is to be carried out.

DUTIES DURING RECONNAISSANCE AND SEARCHING FOR TARGETS.

Lights are started up at the hour ordered. The area of ground is swept successively with the beam, with the object of amplifying the table by locating and disclosing and fixing all range marks and likely targets. To detect moving objects the method described further back should be used. In difficult country especially, the searchlight officer must calculate when the enemy ought to appear at certain spots, and must in his calculation include the distance of the target, the rate of march, and the rate of traverse of the projector. He must not only pay attention to the large targets, but to the small detachments and even to single men, so that he may determine the intentions of the enemy as to his bigger movements. He must be able to recognize the deceptions which the enemy are likely to impose on him. He must give the closest attention to all, and

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even the least important, approaches. In case of an expected "dazzling" by the enemy's searchlights, he must be careful to have ready all protective means. He should inform his tactical commanding officer of all his more important observations. If ordered to keep his lights on a particular object, he must keep them there as long as the firing requires it.

Summing Up.

A few words are here necessary on the advantages and disadvantages to be met with in the illumination of foreground.

If an attacker or defender wishes to carry out night operations without any aids to illumination, it is easy to see that, of the two, the defender is at a disadvantage.

The attacker can choose his course of action, and can carry out at will his intentions, while the defender has to await decision in order to form his counter-plans. The defender in the first line is thus forced to use such means as will make it possible to see at a great distance in order to discover the intentions of his opponent. The attacker can carry out his operations at night without the help of distant illumination. It is sufficient for him to hinder the illumination of the defender. Of all known means for the artificial illumination of foreground, the electric searchlight is incontestably the best. The lighted area is comparatively large. The beam of light can at will be kept fixed on the object, or be made to suddenly change its position and direction. It is often easier to fire at an object illuminated at night, than during the day. The "gear" lasts a long time, is as a rule easily procurable, and can be kept stored. The source of light is a very difficult target. The beam can dazzle and considerably delay or hinder the movements of an opponent. It can also be used for signalling purposes, or be made to serve the purposes of a screen. The disadvantages are that—

(1). Electrical apparatus is expensive.
(2). A highly trained and carefully selected *personnel* are necessary.
(3). The effect of the searchlight is very dependent on the configuration of the ground and the state of the atmosphere.
(4). When small lights are used, a very large number are necessary.

The reproach from all sides that searchlights assist a force to determine his opponent's position and aid him in his advance, arise from peace manœuvres. It is natural that a searchlight can never have good results on unsuitable ground, but on favourable ground it is different. The position of the defenders' works must be known very accurately to the attacker before he plans night operations, and without having first been given away by the searchlights. When during his advance he gets into the beam, instead of being able to fix his whereabouts, it is more likely that he will lose himself and become exposed to the effective fire of the defender, and this can be increased by changing the positions of the lights or by introducing reserve lights. By siting searchlights near "works," hostile fire which may be really intended for the searchlights only is drawn to them. This circumstance must be carefully considered when choosing sites for searchlights.

R. Walker.

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WIRELESS TELEGRAPHY.

Translated from a Lecture by Major Ferrié, of the French Military Telegraph Department, in the *Annales des Ponts et Chaussées*.

Wireless telegraphy furnishes an almost unique example of a scientific discovery arrived at solely by previous theoretical reasoning.

Maxwell having mathematically proved that the properties of light could be compared to those of an electro-magnetic vibratory motion, Hertz sought to verify this statement experimentally, and succeeded in creating electrically a vibratory motion possessing all the properties of light.

Wireless telegraphy—optical telegraphy's first cousin—had been discovered; it was only some years later however, thanks to other scientists, Tesla, Lodge, Popoff, Branly, and last, but not least, Marconi, that this invention was practically made use of.

Before therefore describing wireless telegraphy at its present stage, it may be as well to call to mind the properties of Hertzian waves.

A.—Hertz's Experiments.

If a condenser be connected to the terminals of a source of high-tension electricity, and also to two small metallic spheres, it is found that, if the spheres be brought within a certain distance of one another, the gap between them is bridged by a spark, due to the discharge of the condenser. This discharge is not a sudden neutralization of the electricities of opposite sign on the spheres, but a series of oscillations of the electricity in the discharge circuit, *i.e.*, an alternating current is produced in this circuit, which dies out more or less rapidly according to the resistance of the circuit and of the spark. The frequency of this current is very great and varies with the capacity of the condenser, and with the size and shape of the wires connecting it to the spark gap. Frequencies greater than 1,000 million alternations per second have been produced, *i.e.*, vibratory motions having a wave length of less than 1 centimètre, but they cannot compare with the vibrations of light, the wave length of which is about $\frac{1}{2000}$ millimètres.

These electrical vibrations are transmitted through the atmosphere by means of waves, known as Hertzian waves, which can be reflected, refracted, or polarized just like light waves. They have the property of being able to generate in any metallic circuits they meet alternating currents similar to those produced in the original circuit. This phenomenon can be experimentally illustrated as follows:—Electrical oscillations or alternating currents of high frequency are generated in a circuit consisting of a source of electricity, a condenser, a spark gap, and a few turns of wire wound round a core. A second circuit consisting of a

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condenser of adjustable capacity, a few turns of wire, and a detector is fitted up (*Fig.* 1).

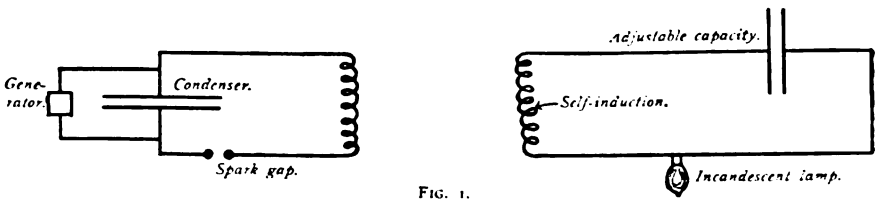

FIG. 1.

Now were this second circuit connected to the source of supply, the frequency of the alternating current generated in it would depend on the capacity of the condenser and the number of turns of wire (*i.e.*, the inductance); so that we see that the two circuits, as fitted up, can be "syntonized," or got in tune, by varying either of these factors. If the two circuits be placed close enough together, an ordinary incandescent lamp can be used as a detector; it will then be noticed that the lamp becomes very brilliant for the value of the factors, which is such that

Inductance of No. 1 Circuit × capacity of No. 1 Circuit
= Inductance of No. 2 Circuit × capacity of No. 2 Circuit,

i.e., when the circuits are syntonized.

The time of duration, T, of an electric oscillation in a circuit of capacity, C, and self-induction, L, is given by the formula

$$T = 2\pi\sqrt{L.C.}$$

The wave length of the vibratory motion produced, *i.e.*, the distance travelled by the vibration whilst the oscillation lasts is given by

$$\lambda = V.T,$$

where V = the velocity of light.

The experiment just described explains the theory of wave meters, that is to say instruments for measuring the wave length of the electric oscillations due to the discharge of a condenser. A wave meter generally consists of a circuit containing an adjustable capacity, an adjustable inductance, and a detector (generally a thermal ammeter). Each apparatus has a reader giving the wave lengths corresponding to various values of the capacity and inductance, from which the desired result is obtained.

Yet another characteristic of alternating currents of high frequency is their power of propagating themselves in open circuits. Thus, if the second circuit of the above experiment be replaced by a straight stretched wire, the centre of which is only a short distance away from the generator circuit, the following phenomena may be observed:—

(1). The vibratory action induced in the wire travels to its extremities and is then reflected.

(2). The incident and reflected vibrations interfere with one another, and if the length of the wire has been properly chosen, it is possible to observe by means of suitable detectors, the production of electrical waves and depressions similar to the vibrations in a stretched string.

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Now the distance between the summits of two consecutive waves or the bottoms of two consecutive depressions, is equal to the wave length of the vibration, so that, provided it is not too long, we have a second method at our disposal of measuring wave lengths.

As soon as Hertz's experiments were known, several scientists declared that if sufficiently powerful waves could be produced, they could be used for the transmission of telegraphic signals. Marconi, when aged 19, was however the first man who made any real attempt to put the Hertzian waves to practical use, and his success is due to the use of a vertical conductor, termed aerial, which increased the distance the waves could travel.

No attempt is here made to describe in detail Marconi's experiments, or the means by which he brought wireless telegraphy to its present state of perfection; it is only intended to give a rough outline of the various forms of telegraph now in use.

B.—Wireless Telegraphy.

The problem of wireless telegraphy can be divided into two quite distinct parts—(*a*) the transmission and (*b*) the receiving of signals.

Transmission is accomplished by producing at a point long and short series of Hertzian waves, combined so as to reproduce the letters of the Morse code. To ensure that the waves will travel some distance, they are generated in a vertical conductor or aerial—either directly or by induction—from a special circuit.

Direct generation of the waves in the aerial was used from the beginning by Marconi; now however it is almost entirely in disuse. In this system the aerial formed one plate of a condenser, whose other plate was the earth. The secondary of an induction coil was connected to this condenser, a battery and key in the primary circuit being the means of signalling. Two metallic spheres at the terminals of the secondary circuit formed the spark gap (*Fig.* 2).

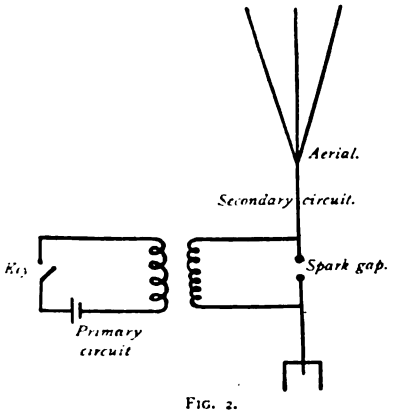

Fig. 2.

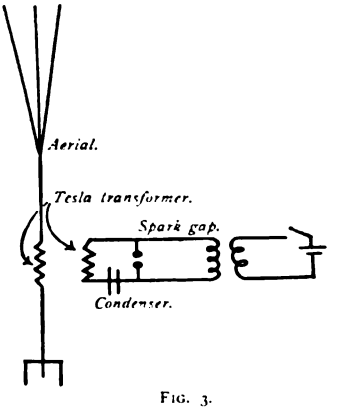

Fig. 3.

In the second method the spark gap is in a special circuit, and the Hertzian waves are transmitted to the aerial by means of a Tesla transformer (*Fig.* 3). The condenser in the special circuit can be charged

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either by an induction coil, or by means of the secondary circuit of an alternating current transformer, of proper size for the frequency of the current and the capacity to be varied. A key in the primary circuit is used for "sending."

Experiment shows that the "range" of the waves increases with the height of the aerial, or, in the case of an aerial consisting of several wires joined at their base, with the area covered.

The waves travel along the surface of the ground, but how, is as yet not well understood. They go round obstacles like sound waves, or rather by a phenomenon similar to the diffraction of light. When they meet an aerial similar to that by which they were produced, they create in it electrical oscillations similar to those which existed in the transmitting aerial. These oscillations are very feeble; they become most intense when the two circuits have the same period of vibration, *i.e.*, when they are syntonized.

The presence of these weak oscillations is detected by making them act on a wave detector either directly or by means of a specially calculated little transformer.

The commonest types of detectors are the Branly coherer, the Ferrié electrolytic detector, and the Marconi magnetic detector. The last two are the most commonly used forms, and are about equally good as regards sensitiveness and ease of use.

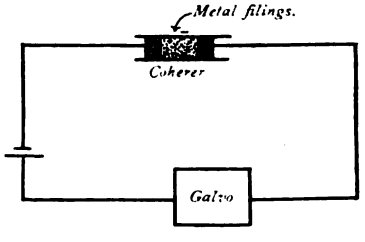

FIG. 4.

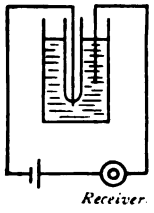

FIG. 5.

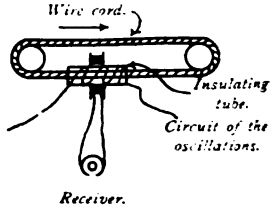

FIG. 6.

The Branly coherer (*Fig.* 4) consists of a glass tube containing metallic filings, between a pair of metallic electrodes. If this coherer be connected in series with a battery and galvanometer, it will be seen that no current flows through the circuit. When however Hertzian waves are produced near the coherer, it becomes a conductor, and remains so after the waves have ceased, but the very slightest tap is sufficient to "de-cohere" it again. It will thus be seen that this apparatus, if provided with a suitable tapper to "de-cohere" it, can be used to receive the dots and dashes from the transmitting station and pass them on to the ordinary telegraph apparatus for the reception of messages.

The electrolytic detector consists of a platinum wire soldered into a glass tube, so that only about $\frac{1}{100}$ millimètres of the wire project beyond the glass into a jar of acidulated water. The wire is connected in series with a battery telephone receiver with a return to the water (*Fig.* 5). As soon as the current flows, the short wire gets polarized and the current stops. Hertzian waves depolarize the point, the current flows, and a noise is

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heard in the receiver; when the waves cease, the reverse process takes place. Telegraphic signals can thus be read "by ear" in the receiver. The Marconi magnetic detector is based on the effect of the Hertzian waves on the magnetization of a cord of thin wire. This cord passes through an insulating tube wound with wires carrying the waves. A coil connected to a telephone receiver is placed round the tube (*Fig.* 6). When the cord is moved in the proximity of a magnet placed near the coil, noises are heard in the receiver. They are due to the currents induced by the changes in magnetization of the cord, under the influence of the electric oscillations.

Other detectors are Fleming's valve and the carborandum detector. The latter is especially useful for transmitting continuous waves. The process described above only produces very much damped vibrations, which begin afresh with each spark, and the reception of signals is not always as clear as might be desired; thus for short distances untuned receiving stations often receive messages not meant for them, even from stations emitting waves of a different wave length to their own. This constitutes one of the disadvantages of wireless telegraphy.

Attempts have been made to obtain good results at receiving stations by means of undamped vibrations, on the following principles:—When a condenser is connected to the terminals of a continuous current arc lamp (*Fig.* 7), it is found that an alternating current, whose frequency depends

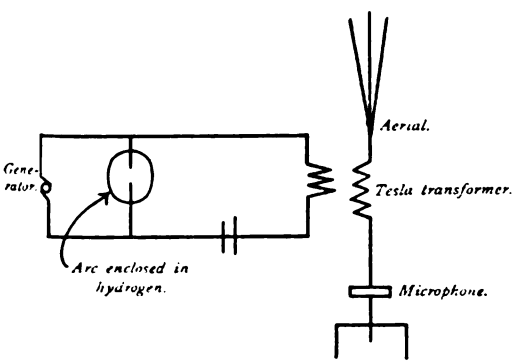

FIG. 7.

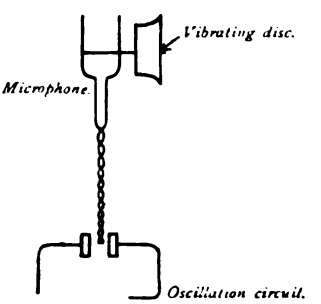

FIG. 8.

on the capacity of the condenser, exists in the condenser circuit, and by giving the capacity the proper values, Hertzian waves of the right strength for signalling can be produced. The best results are obtained when the arc is enclosed in an atmosphere of hydrogen or lighting gas, and when placed in an intense magnetic field.

Attempts have also been made to construct alternators generating high-frequency oscillations direct, but hitherto apparently without any very great success.

C.—Wireless Telephony.

The use of continuous waves and of the "singing arc" have also been employed for the purposes of wireless telephony. The apparatus used is as follows:—The aerial is excited by means of damped waves, an

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arc lamp replacing the spark gap. The microphone is either in series with the aerial or in shunt with the Tesla transformer in the aerial. The best form appears to be a water microphone. This consists of a vibrating disc, which is fixed to a glass funnel terminating in a sharp point (*Fig.* 8). Acidulated water falls from the tunnel; when speaking, the vibrations of the voice induce vibration in the liquid, and the conductivity between the two contacts varies. As these are in the oscillating circuit, variations in intensity can be noticed and the human voice reproduced.

D.—Directional Wireless Telegraphy.

The first attempts made to direct the waves by means of large mirrors, in the foci of which the aerials were placed, met with little or no success.

The use of horizontal aerials, giving a maximum intensity in the opposite direction to that towards which the aerial points, was next tried, but was only useful for short-distance signalling.

Now experiments are being made with a view to utilizing the phenomena of interference by the use of two or more aerials. The results are as yet incomplete, and only allow of a maximum effort being made in one direction and a minimum in the others, and not as in wire telegraphy, of all the effort being made in one direction—along the wire.

E.—Applications of Wireless Telegraphy.

The Navy has most profited by the invention and development of wireless telegraphy. Stations all along the coast communicate daily with the steamers, some of which even edit a daily newspaper with the latest political and commercial news.

The Marconi Wireless Telegraph Company has attempted to compete with the Trans-Atlantic Cable Company, but the service is somewhat irregular on account of atmospheric variations.

It is interesting to note that the military station on the Eiffel Tower at Paris receives all the telegrams exchanged between Canada and Ireland, although 5,000 kilomètres distant from the former country.

In the Colonies and for communicating with lighthouses and lighthouse boats, wireless telegraphy is invaluable, and in any future war it will certainly play a large *rôle*, as has been shown by the French operations in Morocco.

In a word, everywhere where ordinary telegraphy cannot be used, or where it is too expensive, wireless comes to the rescue. It must however be remembered that it has come not to replace but to help its predecessor where hitherto it has been powerless.

A. H. Scott.

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WELLS IN SENEGAL.

From the *Revue du Génie Militaire*, September, 1908.

Between the Senegal and the Gambia there are no rivers of drinking water in the dry season; there are only small streams, which disappear in the sand after a course of a few miles.

Nearly all the water necessary for the population is extracted from the ground, which contains water in variable quantities and at variable depths. These water-bearing strata have been studied methodically since 1904; the results obtained have been classified, and in time a hydrological chart of the country will be available. The knowledge of the location of these water-bearing strata is of great use in forecasting the amount of digging that will be required, but it is also necessary to consider how this can best be done. To obtain water it is obviously necessary to dig a hole; this hole varies in shape and depth according to the resources of the constructor.

The shepherd, who has but a rudimentary stock of tools, prefers to settle near the rivers; he only leaves them when he can no longer find a living for himself or his flocks. He then settles near the pools; when they dry up he digs a hole to follow the descending water level; these holes become deeper and deeper, until the rains come to raise the water level. In Senegal these holes are called "*céanes*."

The *céanes* are nearly always dug in a soft and sandy soil, and when they are more than 6′ deep they are dangerous; they fall in, and there are many accidents. Necessity is the mother of invention, and some natives try to revet them with branches. The *céanes* are generally in the low country, though there are some exceptions. Winter destroys them, and every year they have to be dug afresh.

In some parts a large proportion of the population is exclusively employed in digging these pits. If the amount of labour employed is calculated, it will be seen that this method, which at first sight appears cheap, is in reality expensive, and the construction of wells on the site of these *céanes* would confer great benefit on the natives. They need be only a few feet deep, and the cost would be less than one year of the present labour.

The wells now being sunk in the neighbourhood of Dakar can be taken as an example. Here the natives have dug wells and reveted them with antproof wood from the forest, and some of them have been in existence for more than 50 years. Now that the white man has conquered the country, he has attempted to help the natives by lining the wells, and has found that they may be divided into those in sand, those partly in sand and partly in rock, and those entirely in rock.

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In Longa, Tivaouane, and Thiès the soil is all sand—in many places to a depth of 130′. When a pit is dug in such soil, it must be lined to a greater or less depth. The classic method is to use wood as far as the water-bearing stratum, and then to build a masonry lining on a wheel and lower it by digging below to the required depth. The masonry usually has a thickness of $15\frac{1}{2}''$ and the wood of $7''$, so that for a well of 4′ 6″ diameter the pit must be $4' 6'' + 2' \times 15\frac{1}{2}'' + 2' \times 7\frac{1}{2}'' = 8' 4''$ wide.

The wooden lining gets too dry in the sand and decays; a safer method is to use iron, but this is expensive. The estimate for a well at Longa, 110′ deep, was £690, or £6 per foot. Those at Pont cost £4 a foot, and at Thiès £3 13s. per foot. This method is too expensive for use in Senegal, where more than 100,000 wells would be required to satisfy the needs of the population.

Sheet-iron cylinders were next used, without any masonry. This method has many advantages—among others, that the diameter of the hole to be dug can be reduced. The cylinders can be rolled to the place where they are wanted, the work is easier, and the results better.

This method became general in 1904, but it is not without its disadvantages. The first is its expense. The cylinders cost about 27s. per foot-run in France; wells of 60′ depth cost about £2 a foot. This is a great improvement on masonry, but it is not cheap enough, as the wells have to be built not by the foot, but by the mile.

The reduction of the cost is of vital importance, and the solution has been sought by the substitution of reinforced concrete for sheet-iron cylinders. The former cost about a quarter as much as the latter. This appeared to solve the problem, but we shall see that the solution is not yet a perfect one; and to do this we must go into details of the making of wells with cylinders.

All the methods can be reduced to three, which are quite distinct from one another.

First Method.—When the soil is solid enough to stand without lining. In rocky ground a well is dug without any protection, but when it is clayey, the bottom portions have to be lined with wood or sheet iron, as the water eats away the sides and makes them dangerous.

Second Method.—If the soil is friable, a hole about 6′ deep is dug, two or three sections of the cylinder are joined together and placed in it, and packed round with loose soil; they are then weighted on the top, and descend by gravity as the soil is dug away from inside. Other sections are added at the top and the process repeated. There are two objections:—(1), It is difficult to make the shaft vertical, and if it is not vertical a bucket cannot be lowered into it; (2), the cylinder jams and will not go lower. In this case another cylinder of smaller diameter must be inserted to continue the work; this lessens the available width, and the provision of several different sizes complicates supply. In point of fact, the diggers never use the smaller size—they go on without lining, with the natural result that the well only lasts a few years.

Third Method.—It is however possible to line the whole required depth with cylinders of one diameter. This is done by using sections of the cylinder made, in two halves, of steel which is springy enough to

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admit of their being lowered down the jammed sections and then put together in a space excavated below. Of course the earth must be sufficiently solid to stand up while this is being done. The lower sections inserted by this method hang from the upper ones, which are jammed. The two first methods can be used with reinforced concrete, but not the third one, as it is inelastic. It was easy enough to obtain cylinders of reinforced concrete, but very difficult to place them. Experiments however proved that it was possible to make even sand stand vertically long enough to apply a coat of cement. This affords the possibility of making the cylinders on the spot without moulds. The cylinders can be given the desired thickness, and the bars, which are normal to the walls, bind the layers of cement together. At first two layers of iron, ·31″ thick, and 4″ of cement were used; gradually this was decreased to a layer of reinforced concrete 2″ thick, with the metal forming a trellis of 4″ mesh, made of ·16″ iron, which was very easy to adjust. Many wells lined in this manner have lasted two winters without any damage. Practically it has been found that the first section lined in this way has sufficient friction against the sides to remain in position when the next section is excavated; this can then be lined, and so on to the desired depth. With very slight training, natives who have never handled a trowel can be taught to make wells in this manner up to a depth of 40′ without European supervision.

Cost of the Wells.

The factors affecting the cost are :—

1. *Pay of Natives.*—Generally a native foreman at about 2s. and three labourers at 1s. 3d. a day are employed. Food supply has to be arranged for, as the work is generally far from villages.

2. *Materials.*—The expense per foot-run works out at about 125 lbs. of cement for 4s. 2d. and 6 lbs. of wire for 1s., a total of 5s. 2d.

3. *Transport* (per foot-run).—By rail, about 1s. 7d. a mile; by camel pack, very variable, but about 2s. 6d. a mile.

4. *Supply of water* costs about 10s. a day, by camel pack, when the work is carried on up to 20 miles from the point of supply.

5. *Necessary Tools, etc.*—Very variable. If the wells are shallow, very small; perhaps 2s. per diem.

6. *European Supervision.*—It is necessary to ensure European inspection every two days or so. The expense of course depends on the proximity of the parties to each other. The ordinary civil pay is 8s. 6d. pay and 8s. 6d. travelling allowance.

7. *Administrative Expenses.*—About 1s. 4d. per party per diem.

E. G. Godfrey-Faussett.

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NOTICES OF MAGAZINES.

ARTILLERISTISCHES BLATT.

13th March.

GUNS FOR THE ATTACK OF AIRSHIPS.—The first gun manufactured was mounted on a motor car, had 5-cm. bore, and was 30 calibres in length. The maximum height of the projectile fired was 2,400 mètres.

Krupp have also manufactured another gun 6·5-cm. size, which fires "Brand" shot only. With this kind of shot it is hoped to set fire to the gas of the envelope and to explode it. Their latest gun is 7·5-cm. size, with central pivot mounting. It can be used on board a ship or mounted on a motor car protected by armour. The recoil of this gun is taken up by compressed air, and has been reduced to a minimum.

THE NEW ARMOURED BULLET.—This has been designed for the attack of shielded artillery. Trials have shown that at a range of 600 mètres these bullets can pierce a field gun shield 6 mètres thick. The bullet weighs 10 kgs., and has an initial velocity of 850 mètres per second.

THE NAVAL AMMUNITION MAGAZINE OF THE UNITED STATES, ON THE ISLAND OF JONA, IN THE HUDSON RIVER.—Some detailed information about this is given, with illustrations.

NATIVE MILITIA IN FRENCH TONG-KING.—This native militia was first organized in 1884. At the present time it numbers 7,000 men, whose duties are to ensure protection in the interior, to act as escorts for wheeled transport, as guards in administrative buildings, to man the prisons, and to provide the street police. They are organized now in brigades, each consisting of four sections of 50 men, one brigade being allotted to each district. They are located in posts throughout the districts, and in each province the Resident is allowed a mounted guard of 20 men. These carry lances and swords, whilst the dismounted rank and file are armed with a rifle of 1892 pattern and carry 90 cartridges. These native guards are said to serve very loyally and bravely, and have been known to lay down their lives for their commanders. The existence of this small local force is hardly known, but it gives one some idea of what France is doing in Indo-China.

NOTES.—Germany this year is going to carry out submarine mining operations in conjunction with the fleet.

Trials are also being made at Kiel with acetylene shells, which it is said will replace search lights. The shells are filled with calcium carbide; when they alight on the water and sink, the water runs in through a tube,

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and soon a bright light appears on the surface, which burns for three hours. The actual details which cause the lighting of the gas, etc., are not described.

ACETYLENE SIGNALLING LAMP.—A description is given of a new lamp made by Bittner & Co., of Vienna. The size is $7\frac{3}{4}'' \times 3\frac{3}{4}'' \times 3\frac{3}{4}''$. It is fitted with a shutter worked by a key as easily as a telegraph instrument. It can also be used as a hand lamp. A small pocket is included for taking telegraph forms and pencils. The box is divided into two compartments by a partition, of which one is for the water and the generation of the gas; the other contains the burner, a silver reflector, and a bull's-eye lens. It is fitted with a substantial handle, which, when not in use, folds into a prepared socket.

FIGHTING MOTOR CAR.—This is constructed so as to have a clearance off the ground of 16″ and a total height of 36″ only. The drive is directly on the hind axle, the engine being mounted in rear. A machine gun is mounted in front on a pivot, has an all-round fire, and can be elevated if required. The ammunition is stored in the point of the car and is protected by nickel steel. Wheels are made to be fitted with double solid rubber tyres.

R. WALKER.

JOURNAL DES SCIENCES MILITAIRES.

June 15th, 1909.

FRENCH MANŒUVRES.—The second part of the Russian staff officer's comments on the French manœuvres treats in more detail of the various arms. He considers that the uniform of all arms is on the whole much too conspicuous. The only improvement is an experimental chrome steel bullet-proof cap for the artillery. Lighter packs and greatcoats for the infantry are under consideration. The infantry march well and cheerfully, but keep little order. Their tactical instruction is better when stationed at a distance from Paris. They do not pay much attention to the use of ground, which may in part be due to the bright-coloured uniform, and besides this the officers expose themselves unnecessarily. The Reserves during an action stand up and watch the enemy. The large percentage of reservists considerably affects the efficiency of the whole.

The cavalry have excellent horses and look after them well. They are not trained for dismounted action and probably shoot badly. For mounted work they are well trained, but do not always seize the best moment for attack.

The artillery is excellent in every respect. At these manœuvres only field guns were employed, whereas the Germans employed 6″ howitzers and 8″ mortars. The French are numerically inferior, but they claim equality on account of a superior organization and method of fire.

Machine guns are of the latest Hotchkiss type. Their tactical employment leaves something to be desired, and, as usual, they make poor use

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of the ground. Fire is opened at too long a range, and they unmask themselves prematurely without gaining any advantage by so doing.

The Press takes great interest in the manœuvres, and—quite contrary to the German plan—practically nothing is kept secret.

The officers are decidedly superior to the Germans in general knowledge, but the latter surpass them in military matters. On account of the clear dividing line between those who have risen from the ranks and those who have obtained their commissions in the ordinary way, there is not the same moral unity as in Germany. The generals, though very learned theoretically, lack practice in the field. The men are not at first prepossessing, but improve considerably on further acquaintance.

AUTOMOBILISM.—The final article on "Automobilism" sums up the advantages and disadvantages, and suggests that a committee should enquire into the whole subject, and definitely lay down the requirements of motors for military use. Opinion as to these requirements is still divided, and the experience at the 1908 manœuvres was inconclusive owing to the light test of the motor transport employed.

TRAINING OF OFFICERS.—The question of a training common to all officers has been raised in Italy. Its supporters claim better combination between the various arms would be obtained by this means, and they also wish to better the prestige of the infantry in the eyes of the nation. The first claim is not of much value. The Italian cavalry and infantry officers already have a common training, yet there is a deep gulf between the two arms. A better solution would be to attach officers to other arms of the service, for short courses after finishing instruction in their own branch. It is hardly likely that the second idea would be realized. The engineers and artillery would need special courses after the combined course was done, and by these special courses would be differentiated as strongly as ever.

H. L. WOODHOUSE.

KRIEGSTECHNISCHE ZEITSCHRIFT.

May, 1909.

THE DISTANT AND CLOSE ATTACK IN FORTRESS WARFARE.—By Lieut.-Colonel Frobenius.—Brialmont, in his writings, has recorded his opinion that the technical improvement in the manufacture of destructive weapons, and particularly the progressive development of artillery, has favoured the defence rather than the attack, and that as these destructive weapons continue to improve the defence will grow superior to the attack. The truth of this theory is supported by the generally admitted fact that the defence, owing to better preparation, can get greater effect from their artillery, and can also protect themselves more completely from the hostile artillery fire. This advantage is most conspicuous in the permanent defences of a fortress, in the construction of which every technical appliance is available and time is of little consequence.

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It has always been due to the growing strength of the defences that improved means of attack have been devised, and as soon as these means had transferred the superiority to the attack, it became the object of Engineers to adopt these improved methods to the advantage of the defence, and at the same time to shield the defenders from the effect of these improvements when used by the attack. As however the old fortresses became worthless and the construction of new works took considerable time, there were always periods in which the superiority lay with the attack. It was impossible that every development in the attack should be forthwith nullified by an improved type of permanent fortification, and in this fact lies the explanation of the surrender of a large number of fortresses without adequate resistance.

The great increase in range and power of artillery, due to the introduction of B.L. and rifled guns, was answered by surrounding the kernel of a fortress with a girdle of works instead of a continuous parapet. This not only conferred on the defence an increased power to manœuvre and counter-attack, but, by adopting the improved artillery for the defence also, it forced an early deployment and distant investment upon the attack, and thus brought into being what is now known as the distant attack. Thus the increased range of artillery which the attacker thought would be to his advantage became only a further obstacle to him, as it enabled the defence to prolong their resistance.

This consequence however was not generally recognized. It was thought that the works of the defence could be destroyed at long ranges, and the defenders themselves so weakened that the close attack of former days could be dispensed with, and that the infantry could advance in a series of long rushes without suffering many casualties. The only obstacle deemed worthy of consideration was the artillery of the defence, and it was hoped that, as soon as the attacking artillery was in position, a short duel would reduce this to silence. This theory was advanced with great confidence by artillery officers, and even officers of Engineers were inclined to believe that the *rôle* of permanent fortifications had been played out.

It does not appear that any serious basis for this theory was ever advanced, and the disillusionment at Port Arthur was so sudden that even now there are many in the German Army who think that the German artillery would have produced very different results.

Undoubtedly the prospect of at once procuring the downfall of a fortress by bombardment alone was very alluring to German strategists. Their ideal was at any rate to overcome the fortress by distant attack only, making the close attack quite superfluous. Their sanguine views on the subject resulted in the entire attack of a fortress being divided into the two following parts:—

(*a*). The artillery, or distant attack, in which the fortress artillery was to be so damaged that the infantry could march at once to the assault.

(*b*). The infantry assault.

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The infantry were to advance in rushes, and in a few days the works would be captured.

As no one doubted the ability of the artillery to do all that was required of it in a very short time, the work of the infantry was regarded as extremely simple, and no instruction was considered necessary in peace time.

All need for the slow and costly methods of the close attack being thus happily removed, it naturally followed that the technical troops instructed in these methods were deemed superfluous. Technical instruction was to be devoted solely to the service of the artillery.

In Austria, indeed, the proposal was seriously made to transfer all pioneers, aeronauts, telegraphists, to the artillery, as their activity in fortress warfare would be confined to the service of the artillery. Recent experiences however have entirely destroyed these hopes, and have confirmed Brialmont's opinion that the improvement in artillery is in favour of the defence in fortress warfare.

In Port Arthur, indeed, the Russian artillery was very inferior in quality and numbers, and was also badly sited. Thus what was considered to be the chief obstacle to the attack was in this case peculiarly weak; but with the aid of field artillery and infantry fire it conferred such a superiority on the defence that even in the case of hastily constructed temporary works the attacking side were compelled to adopt the last resources of the close attack, which was so slow in its progress and so productive of heavy casualties that it excited universal astonishment. Supporters of the "Distant Attack" theory endeavour to account for this by stating that the Japanese had not enough heavy guns, and especially howitzers.

This contention is of little value because the defensive works were not heavily protected, and according to previous assertions of artillery experts, should not have been able to resist the artillery which the Japanese actually employed.

The truth however is that the distant attack, far from obviating the necessity for a close attack, is not even able so to support the latter as to bring it to a rapid conclusion. Moreover the improvement in firearms has given to a fortress the power of compelling the attack to begin at greater distances, besides forcing on the attacker a double attack, *i.e.*, distant and close.

With the increased extent of the field of fire, and with the greater freedom of manœuvre conferred upon him, the defender is now much nearer the attainment of his ideal—to hold the fortress till the end of hostilities. This conclusion, drawn from actual experience in fortress warfare, seems to be corroborated by recent examples of field campaigns, where the development of the attack is a much more gradual process than it used to be. The character of the close and distant attack in fortress warfare has changed entirely. It is no longer correct to regard the distant attack as synonymous with the artillery combat and the close attack as equivalent to the infantry assault. We ought rather to divide the infantry attack into two periods, the first of which should include all operations against advanced positions up to the moment when the

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besieged are forced to abandon these entirely, and the attack then begins operations against the main position and comes under the effective fire of the fortress girdle.

The second period would include the further advance, including the final assault.

No period can be set aside as the artillery attack, as the artillery will be invaluable throughout in supporting the infantry advance.

The Distant Attack.—It has long been recognized that artillery cannot expect to come into action under some 4,000 yards of the fortress girdle, and many authorities maintain that at the first investment 7,000 yards will be the minimum range. It will be the object of the attack to deploy his artillery as soon as possible, as without its support the infantry cannot advance. Before the artillery is deployed, the infantry will endeavour by their fire to protect and mask the siting of the guns; if this is successfully accomplished, the delay, before the infantry advance can begin, will be considerably diminished.

When the infantry advance is progressing, it is the duty of the attacking artillery to relieve the infantry from the fire of the hostile batteries, in the first place by drawing the fire on itself and finally by silencing it entirely. Their efforts in this direction may bring about a preliminary duel, in which the opposing batteries seek to silence each other by artillery fire only.

The prospects of a speedy termination to such an engagement are however so remote that such a course of action can only be regarded as a waste of an enormous amount of ammunition.

The duties of the attacking artillery are so manifold that no attacking force will have sufficient artillery at disposal to attempt to carry them all out simultaneously with any prospect of success. It is therefore of great importance that the batteries at disposal should not have their resources squandered against a target better concealed than themselves, unless it is absolutely necessary. It is the first duty of the artillery to select as their target that portion of the defensive line which offers the greatest obstacle to the attack, and which is the greatest source of danger and injury to the attacking infantry.

It is impossible to provide every battery with a separate airship or balloon to observe its fire, but if the fire is concentrated on the most important targets, such means of observation will generally be available.

The Siege of Port Arthur gives us no idea of the great obstacles the infantry advance will meet with, before coming under the fire of the fortress girdle proper, because the Russians precipitately abandoned the most important advanced positions, including the Wolfsberg—which was invaluable for the deployment of the attacking artillery—and withdrew into the fortress itself.

When on July 28th, 1904, they were forced to abandon the Laotsuschan-Jupilasa position and to retire to the line Louisa Bay-Wolfsberg, they thought plenty of time would be available to fortify the new position. Thus this line, which was the most important advanced position, was not properly prepared for defence, and consequently the defending force, which was very weak for so extensive a line, was quite unable to withstand the sudden and overwhelming assault delivered on July 30th.

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The Russians now held only Dagushan on the right and Schuishiyin on the left of the north-east front, although the ground generally was favourable to a gradual and stoutly contested retirement.

Parallel to the line of permanent works and some 1,000 yards to the front there is a slight undulation in the ground, and when the Japanese had captured Dagushan, which enfilades this position, it formed an ideal base for the close attack. In order that the close attack should envelop the left flank however the Japanese had to get possession of the Schuishiyin works (Kuropatkin and Temple Redoubts), and the difficulties and casualties involved in this operation form the only example which the siege affords of the infantry distant attack.

The Kuropatkin Redoubt lies some 1,600 yards from Fort Erlungshan, and it is commanded by the Wolfsberg at a distance of 3,500 yards. As the Japanese had established their artillery on the latter hill, the garrison of the redoubt was not very favourably placed for an obstinate resistance. Yet it maintained its position until the 20th September, and until then the Japanese were unable to begin the close attack against Forts Erlungshan and Sungschushan.

We are therefore justified in concluding that the close attack would have been seriously delayed had the Russians occupied the whole of the rising ground on the Jaho, instead of only two posts on the flanks. As even the unfavourable position of Schuishiyin compelled the Japanese to resort to regular covered approaches, it is improbable that the distant attack of the infantry, even when the attacking artillery has soon obtained a superiority over that of the defence, as at Port Arthur, will be able to progress by a series of rushes.

In the French official instructions the distant attack is described as a series of desperate encounters leading to pitched battles, and this description is much more likely to be correct. If the defence has been properly organized, every suitable advanced position will have been utilized to increase the difficulties of the distant attack and to prolong its duration; consequently for the distant attack alone considerable time will be required. This time cannot be lessened by increased artillery fire alone; the distant attack can only be brought to a successful conclusion by an overwhelming infantry attack closely supported by the artillery.

Because in the past the attacking force has been able to proceed to the attack of the main position with little delay, it must not be thought that this will occur again. On the contrary, it is to be expected that in future a fortress garrisoned by an energetic army under a capable commander will consist of a series of advanced positions, each one of which will only be captured after heavy fighting.—(*To be continued*).

C. OTLEY PLACE.

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BOOKS RECEIVED.

Lectures on the Strategy of the Franco-German War, 1870, up to the Battle of Sedan. By Brevet Major W. D. Bird, D.S.O. Hugh Rees, Ltd., 119, Pall Mall, S.W. 6s. net.

An Introduction to Military Geography. By Brig.-General E. S. May, C.B., C.M.G., G.S., Irish Command. With maps and sketches. Hugh Rees, Ltd., 119, Pall Mall, S.W. 8s. 6d. net.

An Introduction to the History of Tactics from 1740 to 1905. By Capt. A. F. Becke, late R.F.A. Hugh Rees, Ltd., 119, Pall Mall, S.W. 3s. 6d. net.

The French Conquest of Algeria. By Major G. B. Lawrie. Hugh Rees, Ltd., 119, Pall Mall. Price, 6s. net.

Molesworth Metrical Tables. By Sir Guilford L. Molesworth. E. & F. N. Spon, Ltd., 57, Haymarket, S.W. 2s. net.

Handbook on Tacheometrical Surveying. By C. Xydis. E. & F. N. Spon, Ltd., 57, Haymarket. 6s. net.

The B.I. Handbook. British Insulated and Helsby Cables. B.I. Cables, Ltd., Prescott, Lancashire. 7s. 6d. net.

The Frontiers of Baluchistan. By G. P. Tate. Witherby & Co., 4, Newmans Court, E.C. 12s. 6d. net.

Theory of the Recoil of Guns with Recoil Cylinders. By Prof. F. Rausenberger. With three plates. Specially printed from *Artilleristische Monatshefte*. Translated by Alfred Slater. Crosby, Lockwood & Son, 7, Stationers Hall Court, Ludgate Hill. 10s. 6d. net.

The Manufacture of Explosives. Twenty years progress. Four Cantor Lectures delivered at the Royal Society of Arts in November and December, 1908, by Oscar Guttmann. With 11 illustrations and coloured frontispiece. Whittaker & Co., 2, White Hart Street, Paternoster Square, London, E.C. Price, 3s. net.

Spon's Architects' and Builders' Pocket Price Book, 1909. Edited by Clyde Young and revised by Stanford M. Brooks. E. & F. N. Spon, Ltd., 57, Haymarket. Price, 3s. net.

Notes on Magnetism and Electricity. By J. S. Iredell, A.S.C. Gale & Polden, Ltd., 2, Amen Corner, Paternoster Row, E.C. Price, 3s. 6d. net.

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LA MARINE. LE HAUT COMMANDEMENT SES FAUTES, SA RÉFORME. Par "L.M.V." et Capitaine E. Liron. R. Chapelot et Cie, Paris. Price, 2f. 50.

THE "TIMES" HISTORY OF THE WAR IN SOUTH AFRICA. By L. S. Amery. Sampson Low, Marston & Co., Ltd., 100, Southwark Street, London, S.E. 1909. Vol. VI. Price, 21s. net. Vol. VII. 10s. 6d. net.

CHAUDIÈRES MARINES ET ACCESSOIRES. Avec notes de résistance des matériaux et de Thermodynamique. Par L. Jauch et A. Masméjean. J. Alté, Editeur, Quai Cronstadt, Toulon. Price, 22f.

THE INDIAN MUTINY, 1857–58. Selections from the Letters, Despatches, and other State Papers preserved in the Military Department of the Government of India. 3 vols. Calcutta Military Department Press.

THE SERVICES OF THE BENGAL NATIVE ARMY. Calcutta Government Printing Office. Price, 4s. 6d.

A SKETCH OF THE GEOGRAPHY AND GEOLOGY OF THE HIMALAYA MOUNTAINS AND TIBET. By Colonel S. G. Burrard, R.E., Supt., Trig. Surveys, and H. H. Hayden, Supt., Geological Survey of India. Part IV. The Geology of the Himalaya. Calcutta: Supt., Government Printing, India. Price, 2 Rupees.

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CORRESPONDENCE.

TENSION BRIDGES.

SIR,

I notice in the May number of the *R.E. Journal*, an account by Capt. Mozley of "A Proposed Tension Bridge." It is an excellent form of bridge.

About the year 1899, I built a bridge on these lines whilst training recruits at Chatham. No doubt the drawings and calculations are still in the archives of the Training Battalion. The only important difference was that I retained the old form of frame, and did not use shears instead; but that does not affect the principle of the bridge at all. I am not aware of any such bridge having been built previously, although probably this has been the case.

I am surprised that Capt. Mozley finds it necessary to use more wire than for a similar ordinary suspension bridge, for it was the economy of wire in the bridge I constructed, which first made me think of the method.

There was at the time a good supply of $2\frac{1}{2}''$ steel wire rope, but no large cables available. It was the usual practice to stop three parts together and erect an ordinary type bridge. I separated them and used three intermediate transoms, each supported by one $2\frac{1}{2}''$ rope at each end. I was also able to use much bigger frames than for a suspension bridge. In the result, the bridge in question carried infantry crowded at a check, whereas the ordinary form with the same span and the same ropes, only permitted infantry in file crowded, and the bridge was very free from vertical oscillation.

The reasons why Capt. Mozley found it necessary to use more wire, appear to be two in number: In the first place straight inclined ties under the bridge are quite unnecessary to prevent vertical oscillation. In the second place frames or shears much higher than 30′ should be used for a 200′ span, in order to realize economy of wire. If you double the height you almost halve the amount of wire required.

Although for a distributed load no advantage accrues from increasing the lengths of the bays, this is no longer so with a concentrated load. I found over 20′ advantageous. If I recollect rightly this allowed the same strain for the heaviest vehicle, short of siege ordnance, as for infantry crowded at a check. Of course it resulted in a heavier roadway, but that is not an unmixed disadvantage. The unloaded bridge was heavy enough to make the cables very nearly straight lines, and the further straightening caused when a load came on was trifling.

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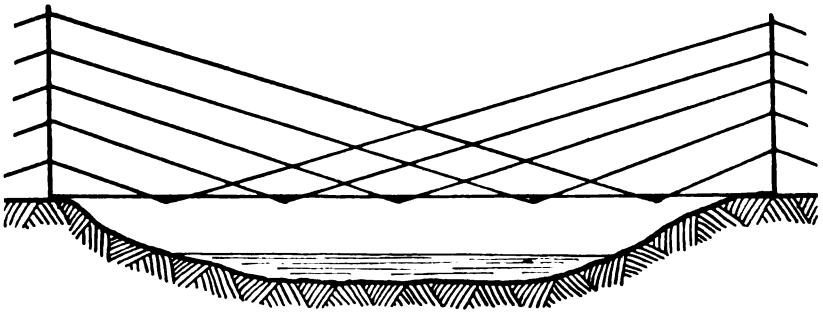
I found no difficulty in adjusting the bridge without using any traveller, which appears to be an unnecessary complication.



The accompanying sketch shows an alternative arrangement which, whilst complicating the frames and anchorages, has the advantage of complete symmetry, and an absence of fore and aft strain on the frames.

G. E. SMITH,
Major, R.E.

The Editor, *R.E. Journal.*

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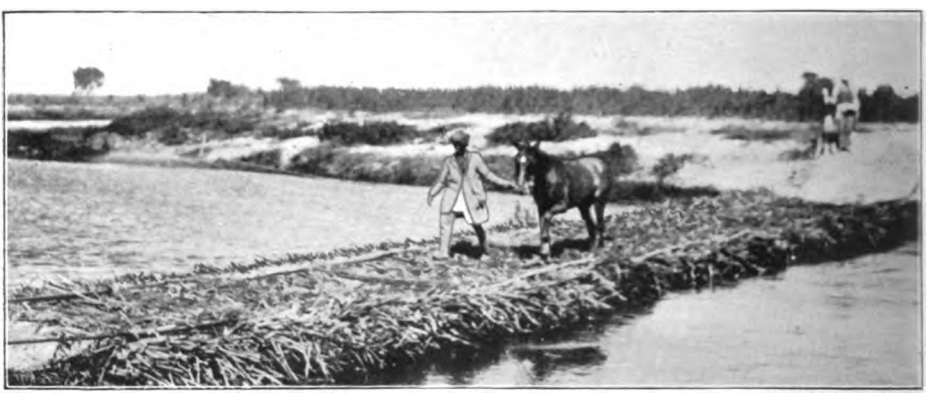
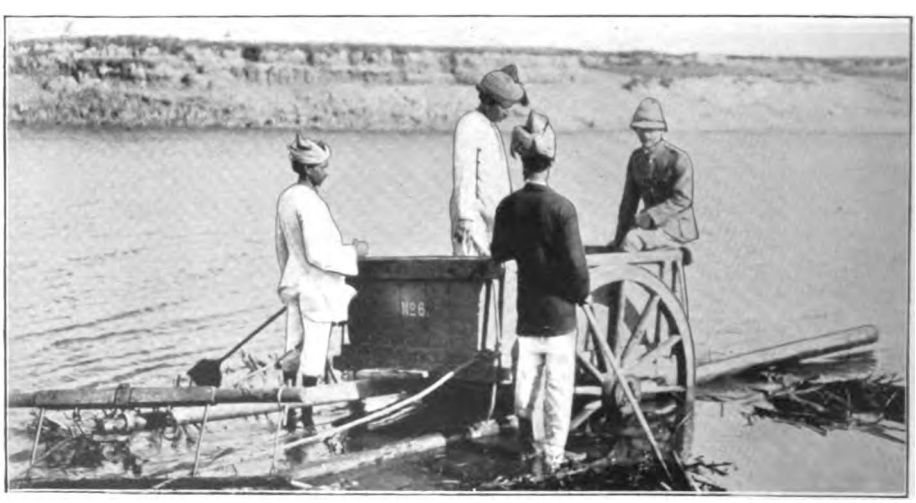
FLOATING MATTRESS BRIDGE MADE OF RUSHES.

1.—Working party in fours crossing the Bridge.



2.—A pony crossing.



3.—RAFTS OF RUSHES.—Bullock cart (weight, 1,360 lbs.) being ferried on 5 bundles of rushes.

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A FLOATING MATTRESS BRIDGE.

COMMUNICATED BY THE COMMANDANT, 1ST (P.W.O.) SAPPERS AND MINERS.

THE following description of a floating bridge, made of rushes and reeds, may be of interest, especially to officers serving in India. The bridge is a very simple one to construct, requiring no skilled labour and very little material beyond the rushes. It should prove particularly useful in swampy country, where the streams are deep and sluggish, and where, although as a rule there are plenty of rushes growing on the banks, there is often a lack of timber suitable for ordinary bridges. The bridge in question was recently made by No. 1 Company, 1st (P.W.O.) S. & M., during its annual training under Capt. A. H. Cunningham, R.E., and was placed across the river Solani near Roorkee, at a site where it was 70′ wide, from 6′ to 10′ deep, the current being 1¼ miles an hour.

The bridge consisted of a number of bundles of rushes, each 10′ long by 1′ 6″ diameter, placed right across the river and touching each other. There was thus a continuous mattress of rushes from bank to bank floating on the water surface, and no waterway at all was left. The bundles were fastened to each other near their ends with lashings of grass rope passed through the wire ties which bound the rushes together, while each bundle was also fastened with grass rope to two 3″ hemp cables, which were stretched across the river 8′ apart, and lay on top of the row of bundles near their ends. The two cables were anchored to holdfasts on the banks, and kept the bridge from being swept downstream. *Photos* Nos. 1 and 2 give a good idea of the appearance when finished.

The rushes were cut ½ mile from the river and tied into bundles 10′ long by 1′ 6″ diameter, with four ties, each of a single turn of No. 14 B.W.G. iron wire. They were carried to the river bank, and there lashed in pairs by three ties, each of two turns of wire, round both bundles, thus making small rafts; these rafts were then put in the water and taken to the bridge site, a mile downstream, by a crew of two men on each, provided with bamboos for poling. On arrival three or four of these rafts were tied side by side to form larger ones, and a bamboo was lashed across each end like a riband.

The large rafts were then floated into place under the two 3″ cables, beginning from one bank, and the cables lashed down to the bundles with grass rope passed through the wire ties. It was found that there was a gap large enough for a man's foot to slip into between

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each small raft and the next, so fascines 8′ × 6″ diameter were laid on top of these gaps. The bridge was then ready for use, taking about 20 minutes to make.

The roadway was of course rather flexible, and undulated when men passed over, but it carried quite easily men in fours, crowded, and ponies walked over without difficulty. It could also be stiffened by lashing down long "bullies" (or poles) as ribands at each side, if the poles were available, while by laying long poles longitudinally as road-bearers across the bundles of rushes, with planks, hurdles, etc., over them, so that the weight was distributed across a length of the bridge, it would be possible to take carts across.

The weight of a bundle (10′ × 1′ 6″ diameter) of "patera" rushes is 150 to 160 lbs., with a safe buoyancy of about 750 lbs. This size is a convenient one to handle on shore or in the water. After the bundles had been floating in the water four days they did not seem to be any less buoyant.

Only certain kinds of reeds and rushes are suited for such rafts and bridges. Most kinds and also most grasses are not buoyant enough, or else they get waterlogged quickly.

Two of the best kinds in Northern India are :—

(1). "*Typha latifolia*," known to natives of N. India as "patēra"; this is a greenish-brown flat-leaf rush, growing in water to about 12′ high.

(2). "*Cyperus alterifolius*," vernacular "tŭkta," a dark green round reed, about 5′ high.

The former is very common in "jhils" and swamps in India. It is also the best on the whole, as it is pliant and bears handling better than the latter, which, although more buoyant, is not only rarer but is also somewhat brittle. Both sorts are very buoyant, even when freshly cut, and do not waterlog. If dried first, rafts made of them will last four or five months in work.

Bundles of these rushes are also very convenient for ferrying. *Photo* 3 shows a cart weighing 17 maunds (1,360 lbs.) being ferried on five bundles (10′ × 1½′ diameter).

There are also two other kinds of grass very commonly found in "jhils," which are however of little use for rafts.

(3). "*Phragmites Roxburghii*."—Vernacular "nărkăll," or "năll," is a tall grass with hollow stem and feathery top; grows to 15′ and more—this is very heavy and soon gets waterlogged. This is the commonest "jhil" grass, and is very useful for fascines for roads, being stiff and strong.

(4). "*Cyperus papyrus*."—Vernacular "jill-mill," a flat-leaf bright green rush, or flag, about 4′ high. This soon gets waterlogged.

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THE ENGINEERS WITH A DIVISION.

By CAPT. A. H. W. GRUBB, D.S.O., R.E.

1. THE Royal Engineers allotted to a division at war strength consist at present of:—

Headquarters,
2 field companies,
1 divisional telegraph company,

with a total establishment of:—

16 officers,
350 N.C.O.'s and men, dismounted,
129 N.C.O.'s and men, mounted,
32 vehicles, and
193 horses.

2. No provision has been made in its organization for a bridging train (35 yards of bridging material is carried by the two field companies), for balloons, or for search lights. With the present allotment in a division of three infantry brigades, three field artillery brigades (besides the howitzers and heavy artillery), and three field ambulances, it seems a natural arrangement to have three field companies, *i.e.*, an additional field company per division.

3. Again, now that the whole Army has been organized on a basis of divisions, it would seem advisable to organize the Engineers wherever possible on this divisional basis, and therefore to have a divisional organization for the existing balloon units (3), bridging trains (2), and search-light units, instead of keeping them as army troops or unallotted, as they now are.

4. To distribute each of the last three named as separate small units in a division would lead to many complications, even if the undoubted advantage of having these auxiliaries always with a division were obvious; and it is difficult to believe that the cost of equipping and maintaining in peace and war six separate bridging trains, six balloon companies, and six search-light companies for six divisions would be faced. It would probably be generally believed, by many officers as well as by civilians, that units bearing the name of balloon companies or search-light companies would only be useful when balloons or search lights were required, and would therefore be useless encumbrances to a force at other times.

5. To obviate this objection and yet provide these special units with each division, I submit that a third field company of the same

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strength as the existing companies in dismounted men, but with a larger number of officers, mounted men, and horses, should be formed for each division, and that it should contain one section for bridging, one section for ballooning (36 men)—the balloon section—and one section for ordinary field company work or a base section. Each of these sections, like that of any ordinary field company, would be capable of performing any work generally falling within the duties of a field company, for which purpose it would have double tool carts with the usual tools. In addition, each section would be capable of performing the special work for which it is organized.

6. It appears to be quite feasible to keep up a company organized on these lines both in peace and war. In peace and war a necessary adjunct to this organization would be the provision of schools for the training of officers, N.C.O.'s, and men in their specialist duties, and to which the whole section should go every year for a portion of its annual specialist training.

7. The sections would have to be kept rather more strictly separate, both in peace and war, than those of other field companies, but the special section could, if necessary, be easily reinforced when required for special work by additional men or horses from the other sections.

The elasticity of the specialist sections, as regards numbers, conferred by this organization, would be a great advantage. In windy weather, for instance, the balloons would require additional help, and if the search lights were required at all regularly at night, additional men for reliefs would be essential. Again, in the event of a long bridge being required, the entire company could, if necessary, be employed on its construction.

8. To enable the company to take its place as a field company, it would be necessary to equip it with the usual double tool cart per section. It could then be employed in road mending, in improving communications, in water supply, and in camping arrangements. These double tool carts would be the only vehicles of the unit which would accompany the first line transport. The specialist vehicles would travel in rear with the ammunition columns, and would only be sent for and brought up to the front when required. It would be necessary for a small proportion of the men to travel with them, to look after them and their special plant.

9. The proposed specialist field company (see Appendix A), would be equipped with what is taken to be the minimum requirements of a division, viz. :—

100 yards of bridging material.

Stores for working one captive balloon, kites or a small dirigible airship.

Four large search lights (90 cms. each), with eight small ones (35 cms.) as alternative.

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Bridging Section.—This would be as approved for a half bridging train by *Field Service Manual, 1908.*

The Army has two bridging trains carrying 200 yards of bridging material each. For the six companies 200 yards more would have to be provided.

Balloons.—One captive balloon and kites or a small dirigible balloon.

The Army has at present three balloon companies. These would have to be developed into six sections, or approximately double the existing strength.

Search Lights.—Four large search lights (90 cms. each), with eight small ones (35 cms.) as alternatives to two larger ones, are proposed.

The Army has at present one search-light company with six large lights and 10 small ones. It is an experimental unit and is unallotted. Eighteen new large search-light plants and 40 small lights would have to be provided.

10. Appendix A gives the war establishment which appears necessary. Eight officers are required as against six in the war establishment of the existing field company, and a great number of vehicles and horses are essential. The establishment provides for fully horsing the vehicles required; but it is now possible to count on mechanical draft for at least half of them. Engine drivers are required for search-light engines, and these could be employed on the mechanical tractors.

11. No alteration in the establishment of the existing field companies is proposed at present, but if it is found later that the two pontoon and one trestle wagon can be dispensed with, they could be attached to the bridging train of the specialist company.

12. It does not seem advisable to include any divisional telegraph units in this company. Their work is quite distinct and they must be directly under the divisional staff, whilst the proposed company would be directly under the Commanding Royal Engineer of the division.

13. The formation of the proposed companies from the existing organization does not present any great difficulties, and does not very appreciably increase the total establishment of the Corps.

At present regimental establishments provide for the following in peace :—

Three bridging trains.—Two with army troops, one unallotted.
Three balloon companies.—With army troops.
One search-light company.—Unallotted.
Three field companies.—Unallotted (one being disbanded).

With a total strength in dismounted N.C.O.'s and men of 517. It is proposed that these 10 separate units be formed into six specialist field companies, each with a war strength of eight officers and 157

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dismounted N.C.O.'s and men; total, 48 officers and 942 N.C.O.'s and men.

The peace strength would conform to that of other field companies, viz.:—Four officers and 116 N.C.O.'s and men. Total, 24 officers and 696 N.C.O.'s and men.

14. In addition to this number, it would be necessary to have depôts or schools for ballooning and search lighting, and the strength both for war and peace is put as under:—

Balloon School.—Four officers and 40 N.C.O.'s and men.

Field Search-Light School.—Two officers and 20 N.C.O.'s and men.

These schools would be in charge of all experimental plant and would put all specialists through a first course of instruction, lasting nine months for ballooning and six months for search lighting.

15. For easy reference, Appendix B gives the approved war establishments of the existing field companies, bridging trains, and balloon companies. There is no approved war establishment for a search-light company, so the establishment recommended by the Committee on Search Lights, 1906–1907, in their report dated February 25th, 1907, is given.

The appendix also gives the peace strength of the existing specialist units and the field companies it is proposed to absorb.

16. The foregoing proposals give an organization which would comply with the conditions and necessities outlined in the first few paragraphs; but if there is any probability of a still further increase of establishment being approved, it would be preferable from many points of view to have three field companies with each division, in addition to a field specialist company and the divisional telegraph company.

17. This fourth company of specialist Royal Engineers should then consist of a headquarter section and a search-light section, with a war establishment of 7 officers, 93 rank and file dismounted, 46 vehicles, 279 horses, with 175 mounted N.C.O.'s and men, as given in detail in Appendix C, and it would not ordinarily carry tools or stores for pioneer or ordinary field company work.

18. The great objection to this fourth R.E. company per division is the large increase of establishment of dismounted men, and the consequent cost that it would necessitate.

In the first case, with the one additional field company per division, including its specialist sections for the six divisions of the field army, the total increase of establishment required would be:—

In peace—8 officers and 180 dismounted N.C.O.'s and men.

In war—7 officers and 254 N.C.O.'s and men.

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In the second case, with three field companies per division and the divisional specialist company, the necessary increase of establishment to the corps would be :—

In peace—32 officers and 550 dismounted N.C.O.'s and men.

These are approximate figures, taking the peace strength of the new units as two-thirds the war strength.

In war—49 officers and 812 dismounted N.C.O.'s and men.

In addition to the above, the establishment required for the depôts or schools, both in peace and war, would be about 6 officers and 60 men.

19. In conclusion, the points it is desired to emphasize are :—

(1). The necessity of having more Engineers with a division.
(2). The necessity of having bridging material, balloons, and search lights with a division in peace and war.
(3). The undesirability of reducing the present war and peace establishments of existing field companies.
(4). The desirability of creating large units rather than a number of small ones.
(5). The importance of making it clear that specialist R.E. units can carry out in the field any ordinary field work usually allotted to the Engineers.

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APPENDIX A.

PROPOSED WAR ESTABLISHMENT OF A SPECIALIST FIELD COMPANY, R.E. (ONE TO EACH DIVISION).

Detail.	Headquarter Section.		Field Company Section.		Bridging Train Section.		Balloon Section.		Search-Light Section.		Total.		Vehicles.	Horses.
	Mtd.	Dismtd.	Mtd.	Dismtd.	Mtd.	Dismtd.	Mtd.	Dismtd.	Mtd.	Dismtd.	Mtd.	Dismtd.		
Major and Captain	2	—	—	—	—	—	—	—	—	—	2	—		
Subalterns	—	—	1	—	1	—	2	—	2	—	6	—		
Staff-Sergeants and Sergeants ...	2	2	—	1	4	1	1	1	1	1	8	6		
Shoeing and Carriage Smith ...	1	—	—	—	2	—	1	—	1	—	5	—		
Trumpeter and Bugler	1	1	—	—	—	—	—	—	—	—	1	1		
Corporals and 2nd Corporals ...	—	—	1	3	6	3	3	3	3	3	13	12		
Sappers	—	6	—	33	—	33	—	33	—	33	—	138		
Drivers	5	—	4	—	78	—	24	—	37	—	148	—		
Batmen	4	—	1	—	1	—	2	—	2	—	10	—		
Total	15	9	7	37	92	37	33	37	46	37	193	157	51	299
Vehicles	1		2		23		10		15		51			
Horses. Riding	8		2		17		8		8		43			
Horses. Draught	4		6		140		42		60		252			
Horses. Pack	—		1		1		1		1		4			
Total	12		9		158		51		69		299			

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APPENDIX B.

War Establishments, 1908–09.—Royal Engineers.

	Officers.	Dismounted N.C.O.'s and Men.	Mounted N.C.O.'s and Men.	Total.	Vehicles.	Horses.	Remarks.
Field Company	6	157	49	212	12	71	
Balloon Company	3	31	31	65	9	50	
½ Bridging Train (right half)	3	12	106	121	23	167	
Recommended. Search-Light Company	5	85	83	173	21	136	Excluding water carts.

Present Peace Establishment of the Following Units (See § and Regimental Establishments, 1908–09).

	Officers.	Dismounted N.C.O.'s and Men.	Mounted N.C.O.'s and Men.
3 Bridging Trains	—	21	3
3 Balloon Companies with Balloon School	8	99	38
1 Search-Light Company	3	49	39
3 Field Companies (4th, 55th, and 58th)	9	348	78
Total	20	517	158

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APPENDIX C.

PROPOSED WAR ESTABLISHMENT OF A DIVISIONAL SPECIALIST COMPANY, R.E. (SPECIALISTS ONLY).

Detail.	Headquarter Section.		Bridging Train.		Balloon School.		Search Light.		Total.		Vehicles.	Horses.
	Mtd.	Dismtd.	Mtd.	Dismtd.	Mtd.	Dismtd.	Mtd.	Dismtd.	Mtd.	Dismtd.		
Major and Captain	2	—	—	—	—	—	—	—	2	—		
Subaltern	—	—	1	—	2	—	2	—	5	—		
Staff-Sergeants and Sergeants	2	2	4	—	1	1	1	1	8	4		
Shoeing and Carriage Smith	1	—	2	—	1	—	1	—	5	—		
Trumpeter and Bugler	1	1	—	—	—	—	—	—	1	1		
Corporals and 2nd Corporals	—	—	6	2	3	3	3	3	12	8		
Sappers	—	6	—	8	—	33	—	33	—	80		
Drivers	5	—	8	—	22	—	35	—	140	—		
Batmen	4	—	1	—	2	—	2	—	9	—		
Total	15	9	22	10	31	37	44	37	182	93	46	279
Vehicles	1		22		9		14		46			
Horses. { Riding	8		17		8		8		41			
Horses. { Draught	4		140		38		56		238			
Total	12		157		46		64		279			

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NOTES ON FIELD EQUIPMENT OF ROYAL ENGINEERS.

By Lieut.-Colonel W. Baker Brown, R.E.

(*Continued from* R.E. Journal, *April*, 1908.)

DETAILS OF TECHNICAL EQUIPMENT.

I. Field Troop.—*Collapsible Boat Equipment.*—Two tri-partite boats, with superstructure for forming a raft, are carried on a special vehicle. The raft is intended for the transport of men, field guns, and light vehicles. Horses cannot be carried. The boats can be used separately, in swimming horses and transporting men, saddlery, etc.

Tools for Military Purposes.—Each section of a field troop carries, in the double tool cart, the following, which is approximately sufficient for one working party of about 20 N.C.O.'s and men :—

Axes	felling	10
	hand	3
	pick (heads 4½ lbs.)	15
Bars, crow (4′ 8″)		2
Hooks, bill		8
Saws, hand		4
Shovels		16
Spades		3
Sandbags		120

Telephones, etc.—Three portable telephone sets, with spare cells, cable, wire, and repairing apparatus, are carried with the Sappers, in light spring wagons, for tapping telegraph lines or making temporary repairs.

Artificers' Tools.—The quantities carried are reduced to the lowest possible, and if a force remains stationary for any time and much R.E. work has to be done, additional tools must be drawn from the

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A.O.D. or obtained locally. A small set of carpenters' and other tools are carried with each section. The G.S. wagon of the unit, in addition to carpenters' and other tools, carries a forge and set of smiths' tools. A very small amount of fuel for the forge is also carried, and must be supplemented by local supplies. A small amount of consumable stores—nails, iron, steel, etc.—is carried, and should be supplemented from local sources.

Stores for Water Supply.—Each section carries on the double tool cart, a pump (lift and force to lift 60′) with hose, and for each pump a 600-gallon waterproof trough, with pickets and the necessary cordage, is carried in the G.S. wagon of the unit.

Explosives.—Each section carries about 140 lbs. of wet guncotton and dry primers, and both electrical and ignition appliances for firing charges. The electrical appliances include an exploder-dynamo, a length of D 15 cable, and detonators No. 13. The ignition appliances are No. 9 safety fuze, Vesuvian matches, and No. 8 detonators.

Signalling Stores.—Flags only are carried with each section, but heliographs and signalling lamps are with the G.S. wagon of the unit.

Survey Stores.—A small set of the usual military sketching and drawing instruments are carried with the G.S. wagon of the unit.

Packages.—Two Clarkson's chests are carried in the G.S. wagon of the unit for packing small stores. They can be used with the pack animals if necessary.

Pack Animals.—The normal loads for Nos. 1 and 2 horses are shown as consisting each of one rack of tools and one Clarkson's chest filled with consumable stores, etc. Nos. 3 and 4 horses each have two Clarkson's chests filled with explosives. No. 5 horse has one Clarkson's chest with tools, blocks, cordage, etc. Extra racks are carried in the double tool cart of each section.

II. FIELD COMPANY.—*Bridging Matériel.*—The amount carried is indicated by the notes to the Table of Transport (p. 8), *F.S. Manual.* This is capable of use as under :—

(1). For a bridge of four bays, using five baulks to a bay, with three points of support (trestle or pontoon).
(2). For a bridge of three bays, using seven baulks to a bay, with two points of support.
(3). For extension of a bridge partly made by another unit, four complete bays with five baulks, or three complete bays with seven baulks.
(4). A trestle pier on each bank, with one raft of two pontoons.

Tools for Military Purposes.—Each section of a field company carries, in the double tool cart, the following, which is approximately

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sufficient for two working parties, each of about 20 N.C.O.'s and men :—

Axes	felling	8
	hand	5
	pick (heads, 4½ lbs.)	18
	„ („ 8 „)	4
Bars, crow (4′ 6″)		2
Hooks, bill		7
Saws, hand		5
Shovels		24
Spades		3
Sandbags		150

Stores for Water Supply.—Each section carries on the double tool cart, a pump (lift and force to lift 60′) with hose, and for each pump a 600-gallon waterproof trough, with pickets and the necessary cordage, is carried in the forage cart.

The Artificers' Tools, Explosives and Signalling and Survey Stores are the same as for the Field Troop, the Headquarters however carrying those stores, which in the case of the Field Troop are carried in the G.S. wagon.

Packages.—Two Clarkson's chests are carried in each forage cart for packing small stores. They can be used with the pack animals if necessary.

Pack Animals.—The normal load is shown as consisting of one rack of tools and one Clarkson's chest filled with explosives. Extra racks are carried in the headquarter wagon.

III. DIVISIONAL TELEGRAPH COMPANY.—(1). *Organization of Company.*—As shown by the "Note" to War Establishment, Section 2 A, *F.S. Manual,* a divisional telegraph company consists of three detachments. Each detachment consists of three mounted and five dismounted N.C.O.'s and men. The dismounted men include two operators, and are carried on the cable wagon. Each cable wagon is followed by a light spring wagon, carrying one operator. Six more dismounted men (including officers' second batmen) belong to the detachment; two of them can be carried—one on the cable wagon and one on the light spring wagon; the remainder march on foot. In addition there are :—

No. 1 Detachment—One officer's batman on spare horse.
No. 2 Detachment—One officer's batman on spare horse.
One C.S.M. (mounted).
One shoeing smith (mounted).
In each detachment—Two sappers (mounted).

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(2). *Telegraph Stores Carried in Wagons.*—Each cable wagon carries 8 miles of cable, with materials and tools for crossings, etc., and two third-class offices, one for the starting point and one to accompany the wagon. Each light spring wagon carries 2 miles of cable and one third-class office, for use as required.

(3). *Third-Class Office.*—A third-class office consists of:—

Batteries, dry, O 6-cell		1
Boxes, tin, filled, plain stationery, Unit C		1
Flag, distinguishing, telegraph		1
Galvanometer { detector Q and I		1
Galvanometer { cases		1
Kettle, camp, oval, 12 quarts		1
Knives, clasp		1
Lantern, field telegraph		1
Mattocks, telegraph equipment		1
Pipes, earth		1
Pliers { side cutting	pairs	1
Pliers { cutters (spare)	pairs	2
Stamps, army telegraph { dating		1
Stamps, army telegraph { paid		1
Telegraph sets, vibrating, R.E.		1
Telephones { receivers, head		1
Telephones { ear cushions		1
Telephone sets { portable "D"		1
Telephone sets { cells, dry		1
Tents, complete D'abri		1
Tools, electricians', large	sets	1
Watches		1
Wire, electric, covered, C 23	yards	20

Telegraph sets, vibrating, R.E., consists of:—One vibrator, telegraph, with brass cover for coils; two adjusting pins; two dischargers, lighting bobbins (without screws); one long securing screw for dischargers; and plug quadruple. One telephone, hand,* C, Mark II., in case.

Telephone set, portable D, Mark I., includes:—Telephone with vibrating call, and telephone, hand, "D," in leather case, with sling. One dry cell for each set is provided separately.

Telephone set, portable D, Mark II., includes:—Telephone with vibrating call, telephone transmitter "D," with capsule, telephone receiver D, in leather case with sling. Two dry cells are provided separately.

(4). *Stationery.*—In addition to the box of stationery supplied to units for military use (which is carried in No. 3 light spring wagon),

* Pending provision of these, "Telephones, hand, A," are being used.

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boxes of technical stationery are carried (Unit C). Each box is hermetically soldered round the bottom after the stationery has been packed inside. The method of opening is by stripping off the tin band forming the upper rim, an overlapping part of the band being left at each end of the box for that purpose. In "War" the boxes are thrown away after being emptied of their contents, but in "Peace" they are returned to the Army Ordnance Department for local repair and re-issue or disposal. The contents of the boxes are shown in mobilization store tables.

(5). *Artificers' Tools.—Carpenters.*—Chest 4 A, filled, one in light spring wagon No. 3.

Farriers.—Bags, tool, farriers', filled, one in light spring wagon No. 2.

Collarmakers.—Holdall, saddlers', one in light spring wagon No. 2.

(6). *Telegraph Tools.*—Each cable wagon carries tools for one working party. Soldering gear in carried in each light spring wagon, though there is only one pot per section.

IV. AIR-LINE TELEGRAPH COMPANY.—(1). *Organization.*—As shown by the "Note" to War Establishment, Section 2 A, *F.S. Manual*, an air-line telegraph company consists of a headquarter and three sections. Each section consists of two working detachments, operators for two second-class offices, and two mounted linemen. The section has four air-line wagons, each carrying 5 miles of air line complete, one second-class office (some of the batteries and stationery are in section G.S. wagon), and tools for one lineman. Two of the air-line wagons each carry tools for a working detachment. The section also has a cable wagon fully equipped with 8 miles of cable, and a G.S. wagon and a light wagon for spare stores, forage, rations, etc. The unit can therefore provide *matériel* for the erection of 60 miles of air line, 12 second-class offices, two third-class offices, and 8 miles of cable. The *personnel* can provide six air-line working parties, operators for 12 second-class offices, and linemen for 120 miles of air line. No *personnel* is separately provided for the cable.

(2). *Office Equipment.*—The following stores are shown in the two types of office :—

			2nd Class.	3rd Class.
Batteries, dry, "O"	6-cell		1	1
	10-cell		6	—
Bells, electric, battery, with case			1	—
Boxes, cash, G.S.			1	—
Boxes, stationery, tin, filled	japanned unit	A ...	1	—
		B ...	1	—
	plain unit	A ...	1	—
		B ...	5	—
		C ...	—	3

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		2nd Class.	3rd Class.
Brushes, watchmakers'		1	—
Commutators, telegraph, 6-line		1	—
Flags, distinguishing, telegraph		1	1
Galvanometers, detector, Q and I, with case		1	1
Kettles, camp, oval, 12 quarts		1	1
Knives, clasp		1	1
Lanterns, field telegraph		1	1
Leather, chamois		1	—
Mattocks, telegraph equipment		—	1
Oil for instruments	pints	$0\frac{1}{4}$	—
Pipes, earth		1	1
Pliers { sidecutting, 3″	pairs	1	1
Pliers { cutters (spare)		2	2
Relays, telegraph, with case		1	—
Stamps, army telegraph { dating ...		1	1
Stamps, army telegraph { paid		1	1
Switches, single and duplex		1	—
Telegraph sets { simplex		1	—
Telegraph sets { vibrating, R.E.		1	1
Telephone { sets, portable, "D"		—	1
Telephone { cells		—	1
Telephone { receivers, head		—	1
Telephone { ear cushions		—	1
Tables, telegraph		1	—
Tents, complete { D'abri		—	1
Tents, complete { telegraph		1	—
Tools, electricians', large	sets	1	—
Watches		1	1
Wick, common	yards	1	$0\frac{1}{2}$
Wire, electric, covered, C 23		50	20

(3). A telegraph set, simplex, consists of:—Wood board, 15″ × 15″, with two wood reels for wire and fitted with galvanometer, single and duplex; instrument, telegraph, sounder, translating; relay telegraph, Mark II., key, double current; switch, single and duplex, four dischargers, lightning bobbin (two spare); and 48 yards of wire, electric, covered, A 3; in transport case.

A telegraph set, vibrating, R.E., consists of:—One vibrator, telegraph, with brass cover for coils; two adjusting pins, two dischargers, lightning bobbins (without screws); one long securing screw for dischargers; and plug quadruple. One telephone, hand, "C," Mark II.,* in case.

* Pending provision of these, "Telephones, hand, A," are being used.

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A telephone set, portable "D," Mark I., consists of:—Telephone with vibrating call, and telephone, hand, "D," in leather case with sling. One dry cell for each set is provided separately.

A telephone set, portable "D," Mark II., consists of:—Telephone with vibrating call, telephone transmitter "D," with capsule, telephone receiver "D," in leather case with sling. Two dry cells are provided separately.

(4). *Linemen's Tools.*—A set of lineman's tools consist of the following:—

Apparatus, repairing, wire			2
Baskets, tool, leather handled			1
Drivers, screw, 9′			1
Galvanometer, detector, Q and I, and case			1
Gimlets, spike, ¼″			1
Hammers, claw, 28-oz.			1
Irons, soldering, tinman's small			1
Knives, clasp			1
Mallet, heel peg			1
Mattock, telegraph equipment			1
Pliers	sidecutting	pairs	1
	cutters (spare)		2
Rods, clearing, obstacle			1
Spanners, McMahon, 9″			1
Telephone sets	portable, "D"		1
	cells, dry		1
Tools, electricians', small		sets	1

(5). *Stationery.*—The japanned boxes, with lock and key, are intended to hold stationery in use, from units A and B. The plain boxes, units A and B, to hold a full supply to replace. The japanned boxes are rendered watertight by strips of basil leather, secured to the inner side of the lid, and resting on the wired edge of the box. The plain boxes are hermetically soldered round the bottom after the stationery has been packed inside. The method of opening is by stripping off the tin hand forming the upper rim, an overlapping part of the band being left at each end of the box for that purpose. In "War" the plain boxes are thrown away after being emptied of their contents, but in "Peace" they are to be returned to the Army Ordnance Department for local repair and re-issue or disposal. The contents of the boxes, units A, B, and C, are shown in mobilization store tables.

(6). *Artificers' Tools.*—Sets of carpenters', farriers', and saddlers' tools are carried in each of the section G.S. R.E. wagons. A forge and set of smiths' tools is carried in the headquarter G.S. R.E. wagon.

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A set of telegraph mechanics' tools with spare parts and materials are included in the war outfit of an air-line telegraph company, but special provision has to be made for transport, as they are not included in the loads of vehicles given in Section 5B.

V. CABLE TELEGRAPH COMPANY.—(1). *Organization of Section.*—A cable company consists of a headquarters and four sections. Each section consists of two working detachments of three mounted and five dismounted non-commissioned officers and men each. The dismounted men include two operators, and are carried on the cable wagon. Each cable wagon is followed by a light wagon carrying one operator. Four more men without horses (including one batman) belong to the section, and are carried one on each cable wagon and one on each light spring wagon. In addition there are :—

1 shoeing smith (mounted).
1 batman (on subaltern's second horse).
3 sappers, linemen (mounted).

The headquarters consist of one working detachment organized as above, the company staff, six spare sappers (dismounted), three mounted linemen, and the spare drivers and horses. Owing to the necessity for carrying rations and ground sheets for these in the light spring wagon, it cannot be used to carry any men. The men without horses march.

(2). *Telegraph Stores Carried in Wagons.*—Each cable wagon carries 8 miles of cable, with material and tools for crossings, etc., and two third-class officers, one for the starting points and one to accompany the wagon. Each light spring wagon carries 2 miles of cable and one third-class office for use as required.

(3). *Third-Class Office.*—A third-class office consists of :—

Batteries, dry, O, 6-cell		1
Boxes, tin, filled, plain stationery, unit C		3
Flags, distinguishing, telegraph		1
Galvanometers, detector, Q and I, with case		1
Kettles, camp, oval, 12 quarts		1
Knives, clasp		1
Lanterns, field, telegraph		1
Mattocks, telegraph equipment		1
Pipes, earth		1
Pliers { side cutting	pairs	1
Pliers { cutters (spare)		2
Stamps, army telegraph { dating		1
Stamps, army telegraph { paid		1
Telegraph sets, vibrating, R.E.		1

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Telephones {	receivers, head		1
	ear cushions ...		1
Telephone sets {	portable, "D"		1
	cells, dry ...		1
Tents, complete, D'abri ...			1
Tools, electricians', large ...		sets	1
Watches			1
Wick, common		yards	0½
Wire, electric, covered, C 23		yards	20

A telegraph set, vibrating, R.E., consists of:—One vibrator, telegraph, with brass cover for coils; two adjusting pins; two dischargers' lightning bobbins (without screws); one long securing screw for discharges; and plug quadruple. One telephone, hand,* C, Mark II., in case.

A telephone set, portable, "D," Mark I., consists of:—Telephone with vibrating call, and telephone, hand, D, in leather case with sling. One dry cell for each set is provided separately.

A telephone set, portable, "D," Mark II., consists of:—Telephone with vibrating call; telephone transmitter D with capsule; telephone receiver D, in leather case with sling. Two dry cells are provided separately.

(4). *Stationery.*—In addition to the box of stationery supplied to all units for military use (which is carried in No. 3 light wagon), 27 boxes of technical stationery are carried (Unit C). Each box is hermetically soldered round the bottom after the stationery has been packed inside. The method of opening is by stripping off the tin band forming the upper rim, an overlapping part of the band being left at each end of the box for that purpose. In "War" the boxes are thrown away after being emptied of their contents, but in "Peace" they are returned to the Army Ordnance Department for local repair and re-issue or disposal.

The contents of the boxes are shown in mobilization store tables.

(5). *Artificers' Tools.—Carpenters.*—Chest 4 A, filled, one per half-company, in light spring wagons 1 and 5.

Farriers.—Bags, tool, farriers', filled, one per section, in light spring wagons 1, 3, 5, and 7.

Collarmakers.—Holdalls, saddlers', one per section, in light spring wagons 1, 3, 5, and 7.

(6). *Telegraph Tools.*—Each cable wagon carries tools for one working party. Soldering gear is carried in each light spring wagon, though there is only one fire-pot per section.

* Pending provision of these, "Telephones, hand, A," are being used.

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VI. BRIDGING TRAIN.—(1). The bridging train is divided into two half trains, which are exactly similar, except for the extra baggage, rations, camp equipment, etc., in the right half for the headquarters of the train, which forms an additional part of it.

(2). *Bridging Material.*—The amount carried is indicated by the notes to the Table of Transport (pp. 8 and 13), *F.S. Manual.*

This is capable of use as follows :—

(*a*). Light bridge, capable of carrying infantry in file, 160 yards of floating and 40 yards of trestle bridge per half train.

(*b*). Medium bridge, capable of carrying infantry in fours, cavalry in half sections, field guns, or ordinary horsed wagons, 80 yards of floating and 20 yards of trestle bridge per half train.

(*c*). Heavy bridge, capable of carrying ox wagons, 60 yards of floating bridge and 20 yards of trestle bridge per half train.

(*d*). Special heavy bridge, double-chessed, with 10′ bays, capable of carrying the 60-pr. gun, 40 yards of floating bridge and 20 yards of trestle bridge per half train.

(*e*). Rafts, capable of carrying the light engine or trucks of the transport and supply park, with landing stages.

(3). *Artificers' Tools.*—Four sets of carpenters' tools, two of saddlers', five of farriers', two of smiths', and two of shoemakers' are carried in the train.

VII. BALLOON COMPANY.—(1). *Organization.*—As shown by War Establishment a balloon company is capable of working one balloon, or one flight of kites.

(2). *Balloons.*—It carries in the field two balloons for work, besides smaller ones for signalling purposes and enough gas to fill a balloon twice. At the advanced depôt four more balloons are provided and six refills of gas.

(3). *Kites.*—A flight of kites consists of one pilot, one carrier, and one or more lifters. One set is carried in the field, and another set is kept at the advanced depôt.

(4). *Telephones.*—Telephonic communication is provided between balloons and earth by means of a light cable. Signalling gear is provided for communication with other units if necessary.

(5). *Tools.*—Carpenters', smiths' and shoemakers' tools are carried for the use of the unit only. No entrenching tools are carried beyond the wagon equipment.

RESERVE EQUIPMENT.—The present system of reserve of stores for the Army is based on the recommendations of a Committee presided over by Sir F. Mowatt in 1900, and the stores are often

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referred to as Mowatt Reserves. In addition to these, there has been in existence for about 20 years a special reserve of telegraph stores, based on the experience of various campaigns, which successfully provided for the requirements of the South African War. The Mowatt Committee laid down a general scale of 100 per cent. of the war equipment in the reserve for R.E. units. The whole of the lists of stores have now been reconsidered and rearranged under new heads, of which the following items affect Engineer services.

FOR SPECIAL EMERGENCIES AND TEMPORARY ADDITIONS TO FORCE.— * * * Item 12.—*Engineer equipment* for demolitions, water supply, entrenching, and siege requirements.

* * * * * *

MAINTENANCE OF THE ARMY IN THE FIELD.—Item 14.—General stores, including vehicles.

* * * * * *

The second of these (Item 14) is taken into the field by the Army Ordnance Dept., and used by them to meet demands from units to replenish equipment.

The amounts stored depend, firstly, on facility for purchase on mobilization being ordered; secondly, probable wear and tear when in use. For the Engineer portion, instead of the uniform scale of 100 per cent., different scales have been allotted to groups of stores; thus ordinary tools are stored to a scale considerably less than 100 per cent., technical stores are held on a larger scale than ordinary tools, and consumable stores, which have to be frequently renewed, on a scale considerably in excess of 100 per cent.

The reserve of telegraph stores is now included in this item, but as the field telegraph work of an army has to interchange a good deal with the work on the line of communications, all the telegraph stores not with units are kept together at Woolwich, and will be issued to the seat of war under the general direction of the Director of Army Telegraphs.

The stores in Item 12 are especially ear-marked for Engineer services, so that it will be one of the duties of the Chief Engineer of a force to advise the Army Ordnance Department what articles and quantities should be sent to the seat of war, also what additional articles should be provided.

All Commanding Royal Engineers of Divisions and their staff officers should also be acquainted with the general kinds of tools and stores held under this item, not only that they may find out what is available, but also that they may know what will have to be provided from other sources. Copies of the list of Mowatt are with the ordnance officers of commands.

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The item is subdivided into separate heads for "Demolition," "Water Supply," "Entrenching and Siege." Under demolitions are stored a stock of the service explosives—dry and wet guncotton—with both ignition and electrical appliances, including a stock of instantaneous fuze, and bags, cylinder and mouthpieces for making up under-water charges.

The water supply stores include some 2,300-gallon waterproof tanks, 600-gallon troughs, several varieties of pumps—steam, borehole, deepwell, lift and force, and semi-rotary—also some Merryweather valiant pumps. Also some $1\frac{1}{4}''$ tube wells and 2 miles of $2\frac{1}{2}''$ light steel water main with couplings.

The entrenching and siege tools include a first supply of the usual entrenching tools, sandbags, and gabions. Also artificers' tools, miners' tools, and lifting tackle, including 6-ton differential tackles, $22\frac{1}{2}$-ton jacks, and various sizes of steel wire rope.

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A PLEA FOR SINGLE-GUN BATTERIES IN COAST DEFENCE WORKS.

By MAJOR C. R. BUCKLE, D.S.O., ROYAL GARRISON ARTILLERY.

IT has long been the custom to build batteries with several guns in line. In the days of the 32-pounder we had our grand battery of 15 guns in line firing through embrasures; later we had heavy guns mounted in casemates in batteries of six or more guns; still later, several guns mounted in one battery *en barbette*, with large traverses between the guns. The area over which the guns could fire was restricted, not by their proximity to one another, but by the manner in which they were protected, *i.e.*, by embrasures, casemates, or traverses.

Batteries of the present day have their guns protected by shields, and are so mounted, that they would have an all-round arc of fire if it were not for the gun on either side of them. Yet we still adhere to the two or more gun type of battery. Is there any good reason for still adhering to this type, which limits the fire effect of our heavy and medium gun batteries, or is it simply an old custom which dies hard?

The design on paper, and the battery when completed may perhaps offer a more pleasing picture to the eye of the designer; but this is only attained at the expense of the efficiency of the battery.

Let us first consider the arc of fire of the guns. The coast defence battery is placed at a disadvantage in this respect compared with its adversary. A ship can alter course and place herself in such a position that she can bring a maximum number of her own guns to bear on her objective, whilst possibly her enemy can only bring a small number of his guns to bear on her. A field battery can change front or position to attain the same object. But in the coast defence battery the guns are chained to one spot; they can only revolve on their own pivots, and therefore, should the objective be on either flank, there is a loss of gun fire at once, since a gun cannot be efficiently fought whilst another gun of the same battery is firing within 30° of it. In the case of a 2-gun battery, each gun loses about 60° on one flank out of the 360° of the circle. In the case of a 3-gun battery, the centre gun loses 60° on each flank, *i.e.*, there is an arc of 120° which it cannot fire over; the flank guns each lose 60°. The single-gun battery is therefore an economy of guns and men; with five well-sighted single-gun batteries we can do the work of four 2-gun batteries.

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The necessity of every gun having an all-round arc of fire is very much more important in these days of long-range fire than it used to be. Nowadays, coast-defence guns may have to fight landwards as well as seawards. At the Siege of Port Arthur the coast defence guns had to be dismounted and the batteries reconstructed to enable them to do so.

As regards the fighting efficiency of a battery, it is incomparably easier to fight a single-gun battery than it is a 2 or 3-gun battery. In the case of the more than 1-gun battery, difficulties arise in :—

(*a*). Determining which splash or hit is due to each gun when observing the fall of shots. This difficulty is increased in the case of medium guns, when two or more projectiles from each gun are in the air at the same time.

(*b*). Passing orders to a gun at a distance from the battery commander's post.

(*c*). Passing different corrections to each gun.

The difficulties attached to fighting a more than one 1-gun battery are so great that in practice we frequently find that a battery commander himself directs the fire of one gun only and delegates the direction of the other guns to his subordinates, who suffer from the disability of having no battery commander's post from which they can observe and direct their fire.

In the case of medium guns which are fought at night against torpedo craft, this delegation of fire direction becomes a necessity, since each gun has a different objective. If the objective be "blockers," the same delegation of fire direction will probably be a necessity on account of the number of ships which have to be fired on simultaneously. In the case of heavy guns, whenever the number of ships bombarding exceeds the number of batteries which can fire on these ships, certain batteries will have to engage more than one ship, for it is a cardinal principle that every ship whose fire is effective must be fired on continuously. If our adversary should decide upon a bombardment, he will not employ a single ship by itself for the operation. We may consider ourselves fortunate if we have one or two heavy guns to spare after allotting one gun to each ship. The heavy coast defence gun of to-day will require to be very well fought to keep down the fire of ten 12″ guns.*

* The increase in the number of heavy guns in a battleship has made the destruction of a dockyard a more feasible undertaking than formerly. For supposing it requires 500 12″ projectiles to seriously damage a dockyard, the fleet of five ships, each mounting four guns carrying a total of 2,000 rounds, could ill spare this amount of ammunition. The modern fleet of five ships however with 10 guns per ship carries 5,000 12″ projectiles, and the loss of 500 will not be felt to the same extent. The improvement in propellants as regards their erosive effect on the bores of guns also helps to make a bombardment a less risky undertaking.

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It not infrequently happens that the most suitable site for a battery has sufficient space for one gun only; under the present system of 2-gun batteries this site would be rejected in favour of one which has space for two guns, so that not only will the guns restrict each other's arc of fire, but the site selected will not be that which from the configuration of the ground gives the largest arc of fire.

In the improbable contingency of the enemy making our batteries the objective of his attack instead of the contents of the place which the batteries are designed to defend, the dispersion of the guns into single-gun batteries will of course considerably increase his difficulty in silencing the guns. Two single-gun batteries may cost rather more to construct than one 2-gun battery. They will also require about four additional men to man them.

As regards the expense in construction, it is a matter worthy of consideration whether in some cases a considerable saving might not be effected by substituting weather-proof buildings above ground for the present underground bombproof shelters. During a bombardment from the sea the *personnel* will be manning their guns, and therefore bombproof shelters will be of no use to them. Continuous bombardment from the land cannot well come upon us as a surprise; should it become probable, "dug-outs" might be constructed for the men to take shelter in when not fighting their guns. Possibly in some cases above ground iron buildings with large removable windows might take the place of our present underground shell and cartridge stores; the cost of construction would be less, the supply of ammunition to the guns might be simplified, and the risk of having our ammunition exploded by gun fire is not great. The case of each new battery ought however to be treated on its own merits; in some positions a battery is very much less likely to be bombarded than in others. When, by departing from the approved type of battery, money can be saved without impairing efficiency, we should not for a moment hesitate to do so.

Where then shall we find the best sites for our heavy and medium gun batteries? The requirements are:—

(*a*). An all-round arc of fire for every gun without interfering with the fire of any other gun.

(*b*). Height to facilitate observation of fire, range-finding, and laying.

(*c*). A forward position with regard to the place which the batteries are designed to defend, in order that the attacker may be kept at a safe distance.

Conditions (*a*) and (*b*) will usually be found on a ridge, hill-top, or spur. In the case of a spur with considerable height, it may be feasible to find two or more sites at heights differing by about 50'.

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For administrative purposes, and also with a view to the replacement of casualties, it will be an advantage if the group of single-gun batteries, which are manned by the same unit, are within 600 or 800 yards of one another.

In conclusion, let us summarize the advantages and disadvantages of the single-gun battery.

ADVANTAGES.

(1). A maximum arc of fire for every gun, enabling every gun to engage the enemy.

(2). Facilities for observing fire.

(3). Simplification in the passing of corrections and orders.

(4). Simplification in the ammunition supply.

(5). Facilities for the distribution of fire.

DISADVANTAGES.

(1). Slight increase in cost of construction.

(2). Slight increase in the *personnel* required for manning the batteries.

Both these disadvantages are more apparent than real, when we can make five single-gun batteries do the work of four 2-gun batteries.

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THE FYERS FAMILY.

By Col. Robt. H. Vetch, c.b., late R.E.

The origin of the family of Fyers, or Foyers, may possibly be traced to an illegitimate son of Hugh, third Lord Lovat, known as "Hutcheon Franchack," or "French Hugh," from his long residence in France. The third Lord Lovat was born before 1450 A.D., and it may be assumed that French Hugh was born towards the end of the 15th century. According to an *Historical Account of the Family of Frisel or Fraser*, by John Anderson, W.S., published in Edinburgh in 1825, French Hugh was the founder of the family of Foyers and of eighteen others in Stratherrick, a glen leading from Loch Ness in which are situated the falls of Foyers.

However this may be, the members of that branch of the Fyers family, which is so closely connected with the Corps and with the services generally, are undoubtedly descended from a Thomas Fyers (probably of one of the Stratherrick families), who was Overseer of the King's Works in Scotland in the middle of the 18th century.

Since I began to write this paper, the Secretary of the R.E. Institute has kindly allowed me to see two letters in the archives of the Institute which refer to a Thomas Fyers, and it was not an easy matter to decide whether this was the same man as the Overseer of the King's Works in Scotland.

One of these letters is as follows:—

To the Rt. Hon. and Hon. the Principal Officer of H.M.'s Ordnance.

Rt. Hon. and Hon. Gentlemen,

I hope it will not be unacceptable that I take the liberty to recommend to your favour one Thomas Fyers, Foreman of the Carpenters at Fort William, for his diligence and activity in the works he was employed in there. But more particularly for his zeal and services to that Garrison during the late Rebellion: at the time that Fort was besieged by the Rebells, the Governor appointed him to act as Lieutenant to a Company of Militia of the townspeople taken in for the service of the garrison, which duty he discharged to the satisfaction of the Governour and rest of the officers, and was upon the command that sallied out upon the Rebells, and drove them from their Battery and spiked up their guns.

This Thomas Fyers served the late Mr. Mowbray, Master Carpenter, as Foreman to all the work he performed in the Highlands, both that which was done under the Direction of Capt. Romer* at Fort Augustus

* Capt. John Romer. See *Roll of Officers of the Corps of R.E.*, pp. 2 and 3.

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and Fort George, and since at Fort William under me, and has always behaved himself faithfully and diligently.

As I know no other way than to your Honours to represent the merits of this man, I beg leave to recommend him to your favour and protection, and that if there is anything he can be employed in your service that you will be pleased to do it.

I am, with the greatest respect,
Rt. Hon. and Hon. Gentlemen,
Your most faithful and most obedient servant,
(Sd.) DUG. CAMPBELL.*

Office of Ordnance,
6th March, 1747.

The other letter is from Thomas Fyers himself, but to whom it was addressed is not stated. It was written from Edinburgh on the 22nd January, 1761, evidently to a superior officer. In it he says he has been ordered by Major Bramham† to report on some repairs to the roofs of the vaults, or casemates, in which the French prisoners were confined (presumably in Edinburgh Castle).

As I had been somewhat impressed by what I had read in the family and other records of the dignity and importance of the position of the Overseer of the King's Works in Scotland, I thought at first that the Thomas Fyers referred to in these two letters must be another man of the same name. In the family records Thomas Fyers is said to have been Chief Engineer in Scotland as well as Overseer of the King's Works, and in *The Patrician* of 1846 he is referred to as one "who for many years filled with credit the situation of Chief Engineer in Scotland, a highly responsible appointment, then connected with the civil branch of the Ordnance Department."

On further reflection however several considerations led me to the conclusion that the gallant militia lieutenant, who was foreman of carpenters at Fort William and distinguished himself in the sortie from that fort, as stated in the letter quoted above, must be the same man who was afterwards the Overseer of the King's Works in Scotland.

To begin with, there was no appointment of Chief Engineer in Scotland. Colonel, afterwards Lieut.-General, W. Skinner was Chief Engineer of Great Britain and was a very constant visitor to Scotland from the middle of the 18th century until his death in 1780. Then, on looking through the pay lists of the staff employed in the superintendence of the construction of Fort George (the large fort at Ardersier Point, on Inverness Firth, which cost some £200,000 and took from 1748 to 1770 to build, including additions), I found that foremen of carpenters, overseers, and draughtsmen were all upon the same footing, sometimes acting as one and sometimes as another.

* Major Dugal Campbell. See *Roll of Officers of the Corps of R.E.*, pp. 3 and 6.

† Major James Bramham, afterwards Major-General. See *Roll of Officers of the Corps of R.E.*, p. 6.

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For instance, Charles Tarrant* was an overseer in 1750, and in 1753 appears in the pay lists as a draughtsman. We know that he became a Practitioner Engineer in December, 1755, Lieutenant (24th) in 1756, and Lieutenant of Engineers in 1759. Thomas Walker† was a similar case. He was an overseer and became a Captain of Engineers. There are other instances of foremen and overseers, evidently of good birth, who became officers in the Army. There is therefore no inherent improbability in the foreman of carpenters, so favourably recommended to the notice of the Board of Ordnance by Major Dugal Campbell, being nominated at a later date to the post of Overseer of the King's Works, which seems to have been a subordinate one, as regards military works, to the senior officer of Engineers in Scotland, and to have been of a civil character.

Moreover, it must be remembered that in those days the Scottish gentry of the highland glens led rough and hard lives, and the children of the small lairds had not many paths of life open to them. A foreman of carpenters implied much more then than it does now, and included a general knowledge of the building trades. A man who had superintended all the building work of the Government defence works of the "Chain" or "Line," as the great road from Fort William to Inverness was alternatively called, consisting of several forts and many military posts, might well have been selected for a more extended sphere of action. The name being the same, the dates fitting in, and the facts as I have stated, I think, in the absence of any evidence to the contrary, that my conclusion is justified.

Thomas Fyers (1715—1784).

Thomas Fyers was born about 1715. He was therefore about 30 years of age when he took part in the defence of Fort William in the "forty-five." It is not precisely stated when he was appointed Overseer of the King's Works in Scotland, but from a reference to him in that position in a letter from the Chief Engineer of Great Britain to Sir George Ligonier in 1752, it may be assumed that it was about 1750.

Fyers was a man of large stature, standing, it is said, seven feet high, and broad in proportion, and his commanding presence attracted general attention as he walked the streets of Edinburgh. He occupied an official residence in the Castle, and enjoyed the reputation of being not only a clever professional man, but also a man of upright conduct and genial disposition.

On the 27th December, 1750, he married Elizabeth, daughter of

* Lieut. Charles Tarrant. See *Roll of Officers of the Corps of R.E.*, pp. 3 and 6.

† Capt. Thomas Walker. See *Roll of Officers of the Corps of R.E.*, pp 5 and 7.

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the Rev. Alexander Falconer of Ferintosh, in the parish of Urquhart, Cromarty. Falconer, like Fyers, was a big man, for he was known as "Alister More," which is the Gaelic for Big Alexander. He had previously been minister of Ardersier in Inverness-shire, and had two sons, one of whom was Fort Major at Fort Augustus.

By his marriage with Elizabeth Falconer, Fyers had a family of nine children—four sons and five daughters—and became the progenitor of many officers distinguished in the Services, including at least nine officers of the Corps. He died in Edinburgh on 17th June, 1784. His widow survived him over 30 years, living in a house he had bought in Prince's Street, which, it is said, afterwards became the New Club.

CHILDREN OF THOMAS FYERS.

The Fyers girls were all married in due course. One of them, Alexandrina, born in 1757, to the Rev. James Reid, minister of Kinglassie, Fife. She became the mother of a very able and well-known officer of the Corps, Major-General Sir William Reid, G.C.M.G., K.C.B., F.R.S., who was Governor successively of the Bermudas, the Windward Islands of the West Indies, and of Malta. He was the author of *The Law of Storms*. He married Sarah, daughter of J. Bolland, Esq., M.P., and had six daughters: Lucy, died unmarried; Maria, married Capt. Edward George Hore, R.N.; Sophia, married Colonel E. G. Hallewell, 20th Foot, who was some time Commandant of the Royal Military College at Sandhurst; Elizabeth, married the Rev. Charles G. Gambier, only son of the Admiral; Charlotte, married Field Marshal Sir Neville Chamberlain, G.C.B.; and Grace, married Capt. Basil S. de R. Hall, R.N., the well-known explorer.

And here I may mention that it is mainly to Sir William Reid's daughter, the late Lady Chamberlain, that I am indebted for information about the Fyers family. When I was writing a memoir of her father for *The Dictionary of National Biography* some 13 years ago, she kindly sent over to Dublin to me all the papers she had about the family, and gave me permission to transcribe anything I wished and to make any use I liked of the information. At that time I hoped to write a memoir of Lieut.-General William Fyers, eldest son of Thomas Fyers, for the Supplement to the *Dictionary*, which was then advanced to letter "R," but the editor was so pressed for space in the supplement that many names of officers of the Corps had to be omitted and among them that of Fyers.

Of the four sons of Thomas Fyers three survived to manhood. William, the eldest, who became a lieutenant-general and a colonel commandant of the Corps, had a large family, and it is about him and his family that this paper is mainly concerned.

Thomas, the third son, born in 1767, became Treasurer of Malta, and died there unmarried in 1815, the same year as his mother died.

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MAJOR-GEN. PETER FYERS, C.B., COLONEL COMMANDANT, R.A.

Peter, the youngest son, was born in Edinburgh Castle in 1769. On the breaking out of the war with France he obtained a commission as 2nd Lieutenant in the Royal Artillery on the 24th April, 1793, without going to the Royal Military Academy. He served during the campaign of 1794–5 in Holland, and was employed on board bomb-ships against the coast of France in 1796, and again in the two following years on various small expeditions. He was promoted Captain-Lieutenant in July, 1799. In 1801 he went with a detachment of Royal Artillery, which accompanied the fleet under Admiral Sir Hyde Parke, to attack the Northern Confederation. Sir Hyde appointed him Acting Engineer to the Force, but at the Battle of Copenhagen under Lord Nelson on 2nd April he acted as senior officer of artillery. As a captain he again served under Lord Nelson, who had been appointed to command the defence flotilla on the S.E. coast in July of the same year, and was with him in his expedition to burn the French flotilla in Boulogne Harbour. He was wounded on this occasion, and Lord Nelson spoke highly of his conduct in his despatch. Thenceforth the great Admiral honoured him with his friendship and confidence.

In 1807 he took part in Lord Cathcart's operations in Denmark, and at the Siege of Copenhagen was aide-de-camp to Sir Thomas Blomefield, who commanded the Royal Artillery. He also served in the Walcheren expedition and at the Siege of Flushing in 1809. In the campaign of 1813–14 in the Netherlands he greatly distinguished himself under General Sir Thomas Graham (afterwards Lord Lynedoch) in the operations against Antwerp. At the action of Merxem, near that city on the 13th January, 1814, when the 78th Highlanders advanced to drive the French out of the village, he himself laid a gun that silenced a battery of several guns of the enemy which were threatening the flank of the Highlanders. He took part in the bombardment of Antwerp and the French fleet in February, and in the assault of Bergen op Zoom on the 8th March, when he scaled the rampart and turned the guns of one of the bastions on the town. For these services performed under the eye of the General he was thanked in general orders and received the Companionship of the Order of the Bath.

On his promotion on the 20th December, 1814, to the regimental rank of Lieutenant-Colonel, he was obliged to return home to take up the command of the Rocket Brigade, to which he had been appointed on promotion; and so to his lifelong regret he missed Waterloo. After holding his command for 10 years he retired as a Major-General. When William IV. came to the throne he showed General Fyers marked attention, having met him on service. Peter Fyers was an able draughtsman, and his views of Arnheim, in Gelderland, of Copenhagen, of Cronsburg Castle, and of the Castle of Nimeguen, on

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the river Waal, were engraved and published in the early years of the 19th century. He married an elder sister of the wife of his nephew, Sir William Reid, Frances, daughter of J. Bolland, Esq., M.P., by whom he had four children, three sons and a daughter. Two of his sons were in the Service and will be noticed later. Major-General Peter Fyers was made a Colonel Commandant of the regiment on 14th June, 1845, and died at Old Charlton, near Woolwich, on 17th May, 1846.

LIEUT.-GENERAL WILLIAM FYERS, COLONEL COMMANDANT, R.E.

William Fyers, the eldest son of the Overseer of the King's Works in Scotland, was born at Inverness on the 6th January, 1753. In order that he might become a military engineer, he was entered as a draughtsman at the Tower of London as soon as he was old enough, and after a few years of preparation there, was appointed Practitioner Engineer and Ensign in November, 1773, when he was nearly 21 years of age.

He began his military duties at Portsmouth, where for some twelve months he was employed on the new defences, and was afterwards moved to Plymouth, where his duties were of a similar kind.

In 1775, Fyers was ordered to America to join the army under Major-General the Hon. William Howe, at Boston, Massachusetts. The precise date of his sailing for America is not given, but as Howe only succeeded General Thomas Gage in the chief command on the 10th October, 1775, it must have been near the close of the year when Fyers joined the army. In an official statement of the distribution of officers of Royal Engineers in North America in the Spring of 1776, Fyers, who was promoted to be 2nd Lieutenant on the 17th January, 1776, is shown with the 3rd Brigade at Boston; the 1st Brigade was in Virginia and the 2nd in Canada. The names of the officers of Engineers serving in the 3rd Brigade are given as follows :—

Capt. Montresor, Chief Engineer.
„ Archibald Robertson.
Lieut. Thomas Hartcup.
„ Henry Haldane.
„ Andrew Durnford.
„ William Fyers.
„ James Straton.

On Howe's withdrawal from Boston to Halifax, Nova Scotia, in March, 1776, Fyers accompanied the army and sailed with it again from Halifax in June for Staton Island. Here Howe's force was augmented by troops from home brought in the British squadron by his brother, the admiral, and also by the return of the joint expedition under Major-General Henry Clinton and Admiral Sir Peter Parker from its unsuccessful attack on Charleston.

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When all was ready a landing near Utrecht on Long Island was effected on the 22nd August, and Fyers took part in the battle of the 27th of that month, when Howe by a masterly turning movement carried the strong position held by the Americans in front of Brooklyn Heights. Fyers also took part in the capture of New York City on the 15th September. After the defeat of Washington in the engagement at White Plains on the 28th October, and the capture of Fort Washington and 3,000 prisoners of war on the 16th November, Fyers crossed the Hudson with Lord Cornwallis in pursuit of Washington. The crossing was above Fort Lee, which Washington was obliged to evacuate in haste. So close indeed was the pursuit that Washington was leaving Newark as the British advanced guard entered the town. From Newark Cornwallis pursued Washington across New Jersey to the Delaware River, and had he not been stopped by Howe might have occupied Philadelphia. But Howe was a Whig, and his mission was not to put down the rebellion with ruthless pertinacity, but rather to allow a loophole by which an ultimate settlement and a reconciliation could be effected. No soldier can succeed if he treats war in such a manner. The army went into winter quarters in December, 1776, and Fyers returned to the main body of the army under Howe, whose troops were disposed in and around New York. Fyers was quartered some 8 or 9 miles from the city, but although the winter was one of great gaiety in New York, he does not appear to have taken much part in it. He rode in occasionally on duty and to attend Divine Service on Sundays. Nevertheless he met his fate in New York. Whether it was during this or a later winter during the war is not stated, probably it was in 1777. The young lady was a Miss Anne Wanton, about whom there will be more to say later on.

Fyers accompanied Sir William Howe's expedition, which left New York on the 24th July, 1777, 18,000 strong, and, after keeping the Americans in suspense as to its destination, finally entered Chesapeake Bay on the 21st August. The landing took place on the Elk River, and Howe marched on Philadelphia on the 8th September. Fyers took part in the Battle of Brandywine on the 11th, when Howe, again by a flanking movement, defeated Washington, and he was also present at the capture of Philadelphia on the 26th September. He remained at Philadelphia until its evacuation the following year.

The Engineers had plenty of work to do at Philadelphia. The Americans endeavoured in every way to obstruct the river below the city, and thus prevent supplies reaching the city by water. Batteries were thrown up on the Pennsylvanian side to oppose the American works on the other side. Later a line of redoubts was constructed between the Delaware and Schuylkill Rivers for the protection of the city, which elsewhere was surrounded by the waters of these rivers.

In the spring of 1778 came the news of the treaty of the Americans

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with France. The surrender of Burgoyne at Saratoga in the previous autumn, due to Howe's want of support, had raised considerable resentment against him, and his resignation was now accepted. Sir Henry Clinton succeeded him in the chief command. In view of the French alliance he decided to evacuate Philadelphia and concentrate his force in New York, where by systematic raids he hoped to wear down the enemy. Philadelphia was evacuated on the 18th June.

Fyers was with the army in the notable march through New Jersey to Sandy Hook, where the fleet lay in readiness to receive it, and he landed with the army in New York on the 6th July, 1778. We next hear of the young engineer in the spring of the following year. He had been promoted from 2nd Lieutenant to Lieutenant on 7th May, 1778, before leaving Philadelphia.

Washington had taken great pains to protect the strategic position at West Point on the Hudson River. The King's Ferry crossing was the principal channel of communication between the Eastern and the Middle and Southern States. West Point itself, where the Americans had their chief magazines and stores, was well defended, and strong posts had been constructed lower down the river at Stony Point on the right bank, and at Verplanck Point opposite, to guard the entrance to the highlands and protect the approach to the key position. Clinton determined to capture these posts.

A force was organized in two columns, one under Major-General Vaughan and the other under Major-General Pattison, Clinton commanding the whole in person. Capt. Mercer and Lieut. Fyers were the Engineer officers detailed to accompany Pattison's column. The columns left Long Island, where they had assembled, on the 29th May, 1779, and proceeded up the Hudson. Pattison's column attacked Stony Point. An official report says : "While the Artillery were dragging the guns up the heights two batteries were in course of erection on the summit of a difficult rock. These were completed with so much expedition that by 5 o'clock next morning (2nd June) the batteries opened fire with a 10″ mortar, an 8″ howitzer, and two 12-pr. guns." The attacks on both posts were successful, and the Engineer officers received due credit. The garrison of Stony Point consisted of 1 captain, 3 lieutenants, 1 surgeon, and 70 men, of which 1 officer and 3 men were killed, while the British loss was *nil*.

The Commander-in-Chief decided to hold the two posts. They were therefore strengthened, especially Stony Point, which commanded the other side. British garrisons were placed in both posts, and Clinton encamped his force further down the river at Phillipsburg.

"For the first time during the war," says a recent American historian of the war, "the British controlled the lower reach of the Hudson River, and Americans coming from the south through New Jersey were obliged to make a detour of 90 miles through the

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mountains to cross the Hudson and enter New England." General Pattison, in a letter dated the 9th June, 1779, gives credit to the Engineers for the rapid way they had prepared new defences to receive their armament. He writes as follows :—

"Stony Point . . . is exceedingly strong from its several commanding heights, and being almost insular by means of a swamp and creek from the river, is very inaccessible, but the Commander-in-Chief, having determined to retain the post and render it as strong as possible, gave orders for batteries to be erected on several eminences. Working parties were immediately employed under the direction of the Engineers, Capt. Mercer and Lieut. Fyers, and so much diligence has been used that there are already seven fascine batteries nearly completed. The guns intended for these works are two 24-prs., two 18-prs., four 12-prs., six 6-prs., one 3-pr., one 10" mortar, one 8" howitzer, two Royal mortars, and two Coehorn mortars, and the platforms will be ready to receive them in a very few days."

About a month later the American General Wayne, with a force of 1,200 men, surprised the garrison of Stony Point by a night attack, and captured the work by assault. Sixty-three of the garrison were killed and the rest surrendered. The Americans lost 15 killed. A simultaneous attack, to have been made by the American General Howe, on Verplanck Point, was unsuccessful, as he was himself attacked in rear by the British and had to retreat. Stony Point, although thus surprised, was only held for a few days, "as it could not be held in the face of Clinton's energy."

In the autumn of 1779, anticipating a combined French and American attack upon New York, Clinton withdrew the garrison from Rhode Island and brought it with the loyalist inhabitants to Long Island, while he kept his Engineer officers busily employed in strengthening the defences of New York. On the failure of the allies before Savannah on the 9th October, Clinton decided to conduct an expedition in person to South Carolina. He pushed forward the strengthening of the New York defences, so that he might be able to leave the city with a small garrison. By the middle of December the works were completed, and having celebrated Christmas Day in the old fashion, he sailed from New York on the day following with 8,000 men for Savannah, as a place of rendezvous for an attack on Charleston.

Fyers accompanied the expedition. The storms of an unusually stormy winter delayed the fleet, several transports and victualling ships were lost, and it was not until the 26th February, 1780, that Clinton appeared before Charleston. The place was invested, but it was the 9th April before the British fleet, under Admiral Arbuthnot, could enter the harbour to take part in the bombardment. The first parallel was finished the following day. By the time the third

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parallel was finished and the wet ditch had been tapped and the water drained off, a heavy bombardment dismounted most of the guns of the besieged, and on the 13th May the place surrendered; 6,000 prisoners and 400 guns were taken, with a British loss of 79 killed and 189 wounded.

In June Clinton left Lord Cornwallis with 4,000 men in charge of South Carolina and returned to New York. Fyers accompanied him, and remained under Clinton's command for the remainder of the war either at New York or in the neighbourhood. At the beginning of the following year, 1781, Fyers married Miss Anne Wanton. Some account of this young lady and her family is given by one of her daughters.*

"My mother's ancestors," she says, "were Quakers of the name of Walton, who emigrated to North America during one of the early persecutions of that sect. They were wealthy, and made large purchases of land at Boston, Rhode Island, and New York. As the family ceased to be Quakers and became members of the Church of England, it may be worth while to mention the circumstances that led to the change.

"During the reign of Queen Anne Rhode Island was much infested by pirates, who were emboldened in their lawless attacks on the settlers because they knew that owing to their religious convictions the Quakers were unlikely to oppose or molest them by armed force. A merchant vessel could scarcely approach the harbour but it was seized by these marauders, who put the crews to death and fitted out the captured vessel to add to the pirate fleet.

"This state of affairs had continued for some time, when two spirited young men, John and William Walton, determined to put a stop to these outrages. They bought a small vessel, hired a crew of brave men, whom they armed, and then sailed to meet the enemy. The crew were concealed below, the brothers Walton alone remaining on deck. As they expected, it was not long before a pirate craft bore down upon them, believing it had got an easy prey. The pirates ran alongside and, having no thought of resistance, were about to board the Waltons' vessel. But at this moment the brothers gave the signal, their armed crew rushed up on deck, killed the pirate captain, and, springing on to the deck of the pirate vessel, mastered the crew, many of whom were below and were completely taken by surprise. The Waltons carried their prize triumphantly into harbour, where they were received with acclamation by the people, who were astonished beyond measure at the success of their daring enterprise.

"But the elders of the sect looked upon the incident with very different eyes. A council was convened, at which it was decided that the Walton

* Sarah Fyers, who married Lieut. (afterwards Major-General) Cornelius Mann, R.E. Her discursive MS. was in possession of her niece, Sabine Anne (daughter of her sister, Charlotte Young), who married Capt. John Jervois Tucker, of Trematon Castle, Cornwall, and a copy of the MS. was made by Lady Chamberlain.

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brothers had transgressed the tenets of the Society of Friends by shedding man's blood, and they were cast out of the Society.

"Indignant at the ingratitude of their co-religionists, the brothers joined the Episcopal Church. The news of the gallant capture of the pirate vessel reached the Mother country, and eventually came to the ears of the Queen. To show Her Majesty's appreciation of the brave deed, Queen Anne sent to each of the Walton brothers a large silver punch bowl, on which was engraved a history of the exploit.

"My grandmother, Anne I think was her Christian name, a sister of these Walton brothers, married a very rich and estimable man, who bore the rather peculiar name of Wanton. They left two sons and two daughters, who were consigned to the guardianship of their uncle, William Walton, Governor of New York. I don't know what became of the elder son; the younger, Joseph, a very amiable youth, was killed by a kick from a horse. The elder daughter married; the younger continued to reside in her uncle's family."

This last paragraph in the lady's MS. has given me some trouble. Firstly, Miss Wanton, who married Lieut. Fyers, and was the mother of Miss Sarah Fyers, the writer of the MS., was born in 1754, and it is difficult to understand how her mother could have been the sister of the valiant brothers of Queen Anne's reign. Secondly, I cannot trace that there was any Governor of New York of the name of Walton. Probably the MS. was compiled from family tradition, and some confusion arose between the somewhat similar names of Walton and Wanton. These names were well known both in Rhode Island and New York. At the time of the Revolution the Governor of Rhode Island was Joseph Wanton, and his father, William Wanton, had also been a governor of the province before him; while at New York at this time a William Walton occupied the important office of President of the Chamber of Commerce, and lived in a well-known house in Pearl Street, New York, called Walton House, afterwards occupied by a representative of the family who was a British admiral, Rear-Admiral Jacob Walton, R.N., who died there in 1844, aged 77 years.

After consulting American histories and biographies, which it must be admitted are very puzzling, I am inclined to think that this paragraph of the MS. might be brought into line by the following reconstruction:—

"My *great*-grandmother, a sister of the Walton brothers, married William Wanton, of Rhode Island, afterwards Governor of the Province. Their son, Joseph Wanton, the last Royal Governor of Rhode Island, was my grandfather. He left two sons and two daughters. The elder son, William, went to St. John's, New Brunswick, where he was Collector of Customs for many years, and died there in 1816. The younger son, Joseph, may have been the Colonel Joseph Wanton who commanded a regiment under General Prescott, which had been locally raised at Rhode Island, and who accompanied the British troops to New York when

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Rhode Island was evacuated, and died there. The younger of the two sisters confided to the guardianship of her *cousin*, Mr. William Walton, President of the Chamber of Commerce of New York, was my mother."

The MS. account continues :—

"During the War of Independence many Americans wished to buy the estates that had fallen to the orphans from both father and mother's sides, and their guardian would have sold the properties on their account, but that the would-be purchasers would only pay for them in 'assignats,' or what was called 'Congress money.' To this Mr. Walton would not listen. 'Old England,' he said, 'was sure to gain the day, and then Congress money would be so much waste paper.' Thus the orphans at the end of the war lost their estates, and got no equivalent.

"Mr. Walton's family consisted of his wife, a very handsome daughter, who, having been educated in England, was more accomplished than the usual run of young ladies of those days, and his niece (? cousin), my mother, Anne Wanton, who was also a remarkably pretty woman. These two young ladies were among the belles of New York. Mr. Walton lived in a handsome house and in good style, and from the position he held it may easily be imagined that his house was the resort of all that was distinguished in society, both civilian and military. I have heard my mother recall a long list of names of persons she was acquainted with in those days who afterwards became celebrated.

"My mother was born in New Jersey on the 17th March, 1754, and was therefore 21 years old when the war began in 1775. She had many offers of marriage, which she declined, and her acquaintance with my father came about in an odd way. On returning from church one Sunday, the cousins asked one of their visitors, General Trotter, if he could tell them the name of the young officer with the very white hands who was so constant in attendance at church. They had not seen his face; he was so attentive to the service, and leant his head on his hand. 'That,' said General Trotter, 'must be Mr. Fyers; he is called "the Good Engineer"; he rides 9 miles every Sunday to attend church service.' 'Oh!' said the ladies, 'do bring him to see us if he should come to New York again. We should like of all things to be acquainted with him.' Accordingly General Trotter brought him to Walton House, and on further acquaintance Mr. Fyers was found to merit all the good that was said of him. He was soon captivated by the beauty and sprightliness of Miss Anne Wanton; they became engaged, and in course of time were married. The marriage was solemnized by the Rev. —. Moore, at New York, on the 4th January, 1781, in the presence of a large circle of friends. The bride was given away by Mr. Walton, and was attended by his daughter and other maids, while the bridegroom was supported by three of his brother officers—Major Archibald Robertson,° Major Alexander Mercer,† and Capt. William Parker,‡ of the Royal Engineers."

° Afterwards Lieut.-General. Died 1820.
† Afterwards General. Died 1816.
‡ Died 1793.

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On the 20th January, 1783, preliminaries of peace were signed, but it was not till the following November that New York was evacuated on the ratification of the treaty. In the meantime Sir Henry Clinton had returned to England and had been succeeded in the chief command by Sir Guy Carleton. When the evacuation of New York took place Sir Guy sent Fyers to Halifax, Nova Scotia, for special duty there under Major-General Campbell. Fyers had now two children, a girl, Elizabeth, born at New York in November, 1781, and a son, Thomas, born in the same city on the 6th January, 1783, and it is recorded that the girl's godparents were Lady Douglas, Major Robertson, and Mrs. Parker, while the boy's were Lieut.-Colonels Robert Morse* and James Moncrieff,† and Mrs. Morrison.‡ Fyers was ordered home in the autumn of the year 1784, the year his father died, and while on leave in London another daughter was born on the 2nd December. She was christened Sarah, and her godparents were Mrs. Thomson, Mrs. Holloway,§ and Lieut.-Colonel William Spry.‖ This is the daughter who wrote the MS. from which I have quoted. Of her arrival in the world she says :—

"At the end of the year 1784 my parents were staying in London in Edward Street, Portman Square, and on the 2nd December I first drew breath there, indeed, my drawing breath was for some time a doubtful affair, I am told, as I was all but stillborn, and it was not without difficulty I was made to live, but there was work for me to do."

On the expiration of his leave of absence Lieut. Fyers was ordered to Gosport. At the time he found himself in a rather embarrassing financial position. He had married a lady of considerable fortune, but after the close of the war she was deprived of the greater part of her private means. The American Government had confiscated her landed property, our Government having made no provision in the terms of peace for the protection of their loyal American adherents.

Unfortunately the sad case of the American loyalists is by no means a solitary instance of the neglect of this country on the termination of hostilities to take adequate steps to protect those who had supported them in time of stress and danger. Too often have such persons found when the crisis had passed and they had ceased to be of use that their loyalty and services were forgotten, and they were left to make the best terms they could get from their recent opponents.

Want of diplomatic action at the end of the American War on

* Afterwards General, Colonel Commandant, R.E., Inspector-General of Fortifications. Died 1818.

† Killed at Hondchoote, near Dunkirk, 1793.

‡ Wife of General George Morrison, who died in 1799.

§ Wife of Lieut. (afterwards Major-General Sir) Charles Holloway.

‖ Afterwards Lieut.-General. Died in 1802.

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behalf of the loyalists was, perhaps, in some degree to be excused, because it could hardly have been conceived possible that a civilized people like the Americans, having won their cause, would have been so small-minded and unwise as to confiscate deliberately and as a matter of policy the estates of those of their own countrymen who had been actively opposed to them in the struggle, and so not only alienate them permanently, but injure the inoffensive women and children dependent upon them.

Yet so it was, and when Fyers went to Gosport with his wife and three children, still smarting under the confiscation of his wife's American estates, another blow awaited him. He was called upon to refund certain pay and allowances he had drawn while serving in America, which had been disallowed by the Treasury.

His daughter thus refers to the time at Gosport :—

"My sisters Charlotte* and Eliza† were born there, and a trying event befell the family. It seems that the agent to the Corps had issued a higher rate of pay to some of the officers in America than he was authorized to do, and the mistake was not discovered until some years had passed, when all were called upon to refund the amount overdrawn. This demand caused much consternation among the officers concerned, and especially to those of small private means. This was my dear father's case. In answer to his application to be allowed to refund the overdraw by instalments he was informed that in consideration of his good service he would be allowed to spread it over a year."

By rigid economy Fyers pulled through, and his daughter records that the time passed happily and peacefully with them, her mother's cheerful disposition making all bright.

* Charlotte, born in 1786. Married Vice-Admiral James Young, of Barton End, Gloucestershire.

† Elizabeth Lydia, born in 1788. Married Major-General the Hon. W. H. Gardner, R.A., third son of the first Baron Gardner.

(*To be continued*).

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MEASUREMENT OF THE SEMLIKI BASE:

WITH

SOME NOTES ON INVAR WIRES.

By Capt. E. M. Jack, R.E.

A joint British and Belgian report on the work of the measurement of the 30th Meridian Arc in the Uganda Protectorate will shortly be published. In the meantime an account of that part which deals with base measurement may be of interest to R.E. officers, especially as the above-mentioned report will probably not be seen by many of them.

That part of the 30th arc which lies in or adjacent to the Uganda Protectorate, between latitude 1° 10′ N. and 1° 10′ S., was surveyed in 1908–9. A base 16½ kilometres in length was measured on the eastern side of the Semliki Valley.

Site.—A site was looked for whose terminals would be about 200′ above the intervening ground. The nearest approach to this that could be found was one in which the ground varied from 65′ near the centre to a maximum of 150′ in other parts, below the ray between the terminals. The ground surface was nearly all that could be desired, the only serious obstacle being a marsh some 700 metres long where crossed. The water in this was rather over knee deep; the bottom rough, but on the whole firm. Work through this section was slow, and great care was necessary to avoid accidents; but the results obtained were equal to those of any other section.

Terminals.—The terminal at the north end, Makoga, was a gently rising spur, which required very little work to fit it for its purpose. The southern terminal, Kibuku, was steep and rocky. It gave some trouble, as towers of rock and earth had to be built to carry the tripods for the six last reaches.

Clearing.—A certain amount of clearing work was done at the end of July, but clearing proper began with a large party and accurate alignment on 4th August, and was finished on the 19th. A path 6′ wide was cut through the grass, which was mostly medium to very thick. In one part a thin wood was crossed, and in another a ramp had to be cut through what was probably an ancient margin of Lake Albert. The time taken is given below. Aligning was done with the 10″ theodolite on to helios after the first 2 miles. Aligning posts,

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about 15′ high, with the upper half covered with white cloth, were put up at about every half mile.

Apparatus.—A full description of the apparatus used, with an account of the preparation and testing of Invar wires, will be found in the pamphlet "Les Nouveaux Appareils pour la Mesure Rapide des Bases Geodesiques," by M. Ch. Ed. Guillaume, of the Bureau International des Poids et Mesures, Sèvres. For the benefit of those who have no previous knowledge, the following short description is given :—

The operation of base measurement consists in the measurement of the distances between a succession of movable points, the forward point of each reach becoming the rear point in the next, and so on. As the measurement advances the points left behind are carried to the front and re-aligned. The movable points consist of tripods, with adjustable heads, fitted with foot-screws for levelling, and capable of a small movement in a horizontal plane. The actual point to which the measurement is taken is a fine cross-cut line on the head of a small vertical pillar. The wire is slung on straining trestles, fitted with pulleys on ball bearings, over which pass cords with weights of 10 kilogrammes attached.

Aligning and placing tripods is done by a forward party, which carries a gauge wire for setting the tripods at the correct distance apart, and a small aligning telescope, fitting on to the upright pillar of the tripod-head, and by means of which each successive tripod is aligned accurately between that last fixed and the distant mark. A small levelling telescope is also provided, which fits on to a special pillar on the tripod-head, and by means of which the difference in level between two tripods can be determined.

The wires are of Invar steel, diameter 1·7 millimetre, and fitted at each end with a scale of triangular section, one edge (along which the scale of 80 millimetres is engraved) being in prolongation of the axis of the wire; the length of each wire from zero to zero of the scales being 24 metres.

Standardization.—For purposes of comparison a test base was laid out 120 metres long, the terminals being formed of iron rails 4′ 6″ long, concreted vertically into the ground with 2′ projecting. The tops of these were filed smooth, and a cross-cut marked with a needle. Comparisons between the three field and the three reference wires were made by measuring this base four times (first and fourth with reference, second and third with field wires). Three such comparisons were made before beginning base measurement; three between the forward and return measures; and three after the base measurement was finished.

During the measurement—when it was found that one of the field wires was giving varying results—comparisons were made on a single bay formed by two tripods. The bay was measured five times, the

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second and fourth being with the field, and the remainder with the reference wires.

Organization.—The party was organized on the lines laid down by M. Guillaume in his pamphlet, as follows:—The two N.C.O.'s, Lance-Corpls. Jones and Page, formed the forward party, and did the setting out and aligning; M. Dehalu, Mr. McCaw, and Capt. Jack took turn about in keeping the record and reading the wires; and Capt. Wangermée did all levelling. Sikhs were employed at first to set the straining trestles, but these falling ill with one accord, the work was done by Swahili porters, who, on the whole, did it very well. One porter was detailed to each tripod, which he had to carry forward when finished with. The two wires were slung one below the other on swivel hooks fastened to two bamboos, which were carried vertically by two porters. A thermometer was tied to each pole between the two wires. This method of carrying the wires, where more than one is used, is probably the best. They are carried without strain and are easily detached and replaced. It would be an improvement to fasten the hooks to the poles with small spiral springs.

Measurement.—The base was divided into sections of about 1 kilometre (usually 42 reaches). The procedure on the outward measure was as follows:—Work was started from the terminal of the previous day's measurement. On reaching the 42nd bay, if the ground was firm and good, the aligning party drove a 2′ iron peg into the ground, and went straight ahead, aligning tripods for the next section. If the ground was unfavourable, they went on for a few reaches before driving the peg. The observing party filed the top of the peg smooth, made a longitudinal groove and fine cross-cut, completed the measurement of the section, and went on with the next. The peg was covered with vaseline and a small cage built round it. On the return measure it was the same, except that there was no preparation of the pegs, and any excess or defect on an exact number of reaches had to be measured with the 8-metre tape.

In this connection it may be remarked that there appears to be no necessity for "transferring" the terminal point to the head of the tripod. Whether done by plumb-bob or theodolite, or even by a special instrument, transference gives room for error; whereas it is perfectly simple to measure direct to the terminal mark. The wire is attached at the terminal end to a spring-balance (merely to save jars), which is fastened to a stick or pole, the point of which is driven a few inches into the ground. The other end of the wire is slung as usual over the straining trestle. The shifting of the scale for the readings is done by the man holding the pole, without removing the point. It is necessary of course to measure the difference of level between the tripod head and the terminal. This

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is done with a level and staff in a few minutes, and when everything is in working order should be completed by the time the observers come up.

With regard to the observing, each bay was measured with two wires, and three readings taken on each wire, a fourth being taken if the range was as great as 0·3 millimetre. This number of readings appears to be ample; a fourth reading was the exception. When carrying out comparisons however, three readings were taken if the range did not exceed 0·15 millimetre, one more if the range was 0·2 millimetre, and five readings if the range exceeded 0·2 millimetre.

One tripod was always left standing in rear until the bay in front had been finished. After intervals for meals the bay last measured was re-measured, and if there had been any serious discrepancy between the two measures, the bay in rear would also have been re-measured; but this was never found necessary.

The recorder, besides noting the readings of the two thermometers fixed to the wire poles, also took that of a swing thermometer, or it would be more accurate to say that he did this until all the swing thermometers were broken. The recorder kept the tot (*i.e.*, the summation of the scale readings) going the whole time, so that it was always possible to know how much in excess or defect of an exact number of bays we were. We were also by this means always able to avoid measuring a short piece with the tape, in our case an important matter, as the tape did not arrive until we were more than half-way through the base. The levelling as above-mentioned was done by one officer, and the results kept in a separate book.

On the end sections, or in any part where the slope was steep, the pillars of the tripod heads were arranged at right angles to the slope, instead of vertically, as usual on approximately level ground. On steep slopes all levelling was done with level and staff.

Speed.—On the Semliki Base there was never a chance of developing anything like the full capacity for speed possible with the Guillaume apparatus. In the first place, there were only six tripods, and this number is not enough. To guard against accident, one tripod must be left untouched in rear until the bay in front is finished; and it would be better to leave two. With six tripods there was therefore no room for elasticity, and when the whole party was thoroughly expert the observers continually pressed on the aligners, and had to wait for them. The minimum number of tripods for proper working is nine, and it would be better to have ten. Again, on the return measure, one observer was unfortunately taken ill, and for the remainder of the time both reading and recording had to be shared by the other two, work which proved very trying after a time.

The usual day's work was two sections of 42 reaches, or a total of 2,016 metres. This took from daybreak to 3 p.m., with two intervals of about an hour each for breakfast and lunch, and works out at 288

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metres per hour for actual measurement; but it should be noted that this includes everything from start to finish, *i.e.*, delays for reasons given above, getting out wires and returning them, fixing terminals, etc. For a complete bay, *i.e.*, from first reading at one to first reading at the next, the time was usually 3 to $3\frac{1}{2}$ minutes, which represents a speed of 411 to 480 metres per hour. M. Guillaume mentions in his pamphlet a speed of 1 kilometre an hour, but I do not think that this can include extras as above, nor measuring with two wires, and the measurement would be of course made by European assistants only. With nine tripods and a full *personnel* we would have been able, I think, to measure 3 kilometres, or over 2 miles, a day.

Field Calculations.—By keeping the tot going all the time, the recording book was ready to be handed to another observer for checking almost as soon as work was finished. This latter observer also entered up temperature corrections. The leveller got out his level corrections, which were checked by an observer, and it was usually possible, within a few hours of finishing measurement for the day, to arrive at the length of the section. In the return measure this length had to be compared with that of the first measure, to see whether it was necessary to measure the section a third time. The limit of difference allowable between first and second measures was adopted as $4\sqrt{K}$. millimetres, K being the length of the section in kilometres.

The form for recording readings, etc., as given in M. Guillaume's pamphlet, in which each bay is made the subject of a separate sum, seems rather cumbersome. A considerable amount of labour is saved by dealing with each wire as being of its standardized length—*i.e.*, the length given to it by field standardization, and by treating everything above as a correction, *i.e.*, for readings, temperature, level. So that the length of a section was obtained thus: n reaches $\times l$ (length of wire) $\pm \Sigma$ readings $\pm \Sigma$ temperature corrections $- \Sigma$ level corrections. As in the following example, taken from the book. The level correction is not included here, being the same for both wires, and taken from the level book.

Section IX.—42 *Reaches.*

	ms. mms.	ms.	mms.
Wire 119:—	$42 \times (24 - 1{\cdot}738)$	$= 42 \times 24 - (42 \times 1{\cdot}738 + 01{\cdot}63 + 12{\cdot}71)$	
		$= 42 \times 24 - 58{\cdot}66$	
Wire 121:—	$42 \times (24 - 2{\cdot}016)$	$= 42 \times 24 - (42 \times 2{\cdot}016 + 11{\cdot}99 + 12{\cdot}71)$	
		$= 42 \times 24 - 59{\cdot}97$	
Mean	$42 \times 24 - 59{\cdot}32.$		

The record was kept in small notebooks in the form given below.

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No. of Reach.	Tripods.	Wire.	Temp. †	Fore.	Back.	Difference. F - B.	Mean.	Summation. 119	Summation. 121	Corrections to Summation. 119	Corrections to Summation. 121	Temp. Correction. ‡	*Notes* (*not in original*).
								−175·51	−170·97	—	−0·03	+0·72	Totals brought forward.
13	4—5	119	F. 18·7	551	414	+13·7	+13·70	−161·81					
				237	100	·7							* Tripods were numbered as an additional precaution.
				580	443	·7						+0·10	
		121	(6) 19·3	176	034	+14·2							
			(7) 22·0	663	523	·0	+14·10	—	−156·87				† F. is the frond or swing thermometer. (6) and (7) the two attached.
				329	188	·1							
14	5—6	119	F. 20·0	173	017	+15·6							
				521	366	·5	+15·50	−146·31					
				205	051	·4						+0·09	‡ Temp. coeff. for these two wires was the same.
		121	(6) 19·0	443	283	+16·0							
			(7) 21·4	681	523	5·8	+15·90	—	−140·97				
				208	049	5·9							
				380	430	− 5·0	5·02						
15	6 - 1	119	F. 19·3	137	188	·1	− 5·07	−151·38	—	+0·05			*Corrections to Summation.*
				583	632	4·9·1						+0·10	Corrections to errors in addition, meaning, etc., are entered in these columns and not carried through the work.
				289	340	·1							
		121	(6) 19·1	110	156	− 4·6							
			(7) 22·0	448	495	·7	− 4·63	—	−145·60				
				634	680	·6							
16	1—2	119	F. 22·1	406	265	+14·1							
				653	512	·1	+14·13	−137·25					
				202	060	·2						+0·13	
		121	(6) 20·0	396	250	+14·6							
			(7) 23·8	686	542	·4	+14·47	—	−131·13				
				398	254	·4							
										+0·05	+0·03	+1·14	Totals carried forward.

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Tables.—Tables are supplied in the French pamphlet for (1), corrections for difference of level; (2), secondary corrections for deformation of catenary; the argument in these tables being the tangent of the angle of slope as given directly by the scale in the small levelling telescope. The use of a level and staff for the terminal reaches of a section, and for steeper slopes than the small telescope could read to, necessitated the construction of tables giving the necessary corrections, in which the argument was expressed as difference of level in feet. Again, though the levelling telescope gives the true tangent of the angle of slope whatever be the length of the bay, the table supplied only gives the true horizontal correction when the bay equals 24 metres exactly. The correction is of course small, but not negligible. Further, to obtain the true mean height of the base, and for other reasons, it was necessary to keep a record of the difference in height of the section terminals. Tables were constructed for these purposes, and will be published in the joint report.

Results.—The following results are preliminary only, and subject to modification.

The figures under the head of "Measures" below are the corrections in millimetres to the total number of reaches in each section × 24 metres.

Section.	No. of Reaches.	Measures.				Difference 1st—2nd, *or*, Mean of 1st and 3rd—2nd.
		1st.	2nd.	3rd.	Mean.	
I.	43	−1760·05	−1750·80	—	−1755·42	−9·25
II.	47	− 128·24	− 126·75	—	− 127·49	−1·49
III.	42	− 741·52	− 744·50	—	− 743·01	+2·98
IV.	42	− 224·51	− 219·13	− 219·37	− 221·00	−2·81
V.	42	− 158·91	− 159·38	—	− 159·14	+0·47
VI.	42	− 157·50	− 153·00	− 153·52	− 154·67	−2·51
VII.	42	− 120·30	− 122·40	—	− 121·35	+2·10
VIII.	42	− 108·62	− 107·82	—	− 108·22	−0·80
IX.	42	− 133·55	− 131·49	—	− 132·52	−2·06
X.	42	− 93·51	− 92·01	—	− 92·76	−1·50
XI.	39	− 99·32	− 102·04	—	− 100·68	+2·72
XII.*	42	− 103·07	− 107·43	− 105·43	− 105·31	+3·18
XIII.	42	− 125·77	− 126·97	—	− 126·37	+1·20
XIV.	42	− 120·29	− 119·53	—	− 119·91	−0·76
XV.	49	− 125·15	− 126·96	—	− 126·05	+1·81
XVI.†	49	[−1804·82]	−1775·43	−1782·52	−1778·97	−7·09
XVII.‡	—	+3881·60	+3881·77	+3881·43	+3881·60	+0·25
	689	−2097·68	−2083·87	—	−2091·30	−13·56

* Marsh section.

† 1st measure not included; considered unreliable on account of weather conditions and other reasons.

‡ 1st and 2nd with common steel tape; 3rd, with Invar.

	Ms.
689 reaches of 24 ms.	= 16,536·00000
Σ corrections	− 2·69130
Length of base on Semliki Plain	16,533·90870
Assuming height of base above M.S.L. to be 645 ms., reduction to S.L. gives about	1·67688
Length of base on geodetic surface	16,532·23181

(Log = 4·2183315).

The discrepancy between mean of 1st and 3rd measures and the 2nd is—

13·56 mms. = 1 in 1,219000.

The P.E. (of measurement only) is—

4·83 mms. = 1 in 3,423000.

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TIME AND COST.

Preliminary Work.

	Men.	Days.
Clearing and alignment	40	21
Preparing southern terminal slope	6	7
„ northern „ „	70	14
Cutting ramp, Section III.	20	4
Making test base	4	1
Total men and days	1,946	

Measurement.

Personnel	6 Europeans, reduced to 5 after 7th Sept. 18 Natives.*
Time	38 days.

In the following, for preliminary work, the cost of the men actually employed is taken; for the measurement it is assumed that the whole expedition was employed, as was practically the case.

For purposes of comparison, the Belgian officers are estimated at the same rate of pay and equipment of porters as British officers; but this cost did not of course fall on British funds.

Preliminary Work.

	£	£
Europeans	61½	
Natives (with food)	35½	97

Measurement.

Europeans	264	
Natives† (with food)	137	401
		498

= £50 a mile, nearly.

In addition to the above there is the cost of the apparatus, as follows:—

	£
3 wires and all apparatus brought out by A.C.B.C. ...	100
3 wires, tape, etc., brought out for arc measurement ...	40
Transport, etc., say	10
	£150

* On the measurement; others were employed shifting camps, etc.
† 100 Swahilis, 60 Ba-toro, 12 boys.

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NOTES.

Elevated Terminals.—There can be little doubt as to the advantage of elevated terminals to a base line. The principal source of error in base extension is due to triangle errors, these being in turn due to the fact that the rays of the first triangles are necessarily close to the ground. To get the required elevation and to get clear of the intervening ground, it is necessary to measure up more or less steep slopes.

Jaderin considered 1 in 8 the steepest slope advisable. The Guillaume telescope reads to a maximum slope of $\frac{1}{10}$ with the ordinary wire; with the long-arm wire one can read to a greater slope, but it is questionable whether steep slopes can be determined with sufficient accuracy with this telescope. On the Semliki Base we measured a maximum difference of level of 15′, or a slope of $\frac{1}{5{\cdot}2}$, and a number of others approaching this.

Unfortunately, I cannot point to the results of our terminal sections as justifying our confidence that slopes up to $\frac{1}{4}$ or $\frac{1}{5}$ can be measured with the highest accuracy. On the other hand, there were obvious reasons why our results did not come up to the standard we expected. The officer in charge of the levelling had not had previous experience of this work, and was further handicapped by the fact that the level at his disposal was too small, and in several respects faulty in construction, so that it was almost impossible to do precise levelling with it.

In measuring up steep slopes the whole thing depends on levelling, the measuring itself being as easy as on level ground. The correction to obtain the true horizontal projection increasing very rapidly with increase of slope, very accurate levelling becomes of the highest importance. With proper instruments this should present no difficulty, and had we been able, when measuring the base, to use the first-class level which was lent to us later by Capt. Stevenson, R.E., we should most probably have obtained the highest results.

Apparatus.—The apparatus used was that designed by M. Guillaume, and described in his pamphlet, and was constructed by J. Carpentier, of Paris. It is in nearly every respect perfectly adapted for its purpose. The tripods stand in the most remarkable way, showing no perceptible movement after hours in a tropical sun. The cases, as supplied, are not strong enough for use in the tropics; most of them fell to pieces during work on the Semliki. The springs which hold down the foot-screws of the tripod heads are also too weak. They are made of brass, and would be better of steel.* The levelling telescope is a very neat and handy little instrument, but it is questionable if it is accurate

* In the latest pattern these springs are made of steel.

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enough for precise work. It is small, and the level attached to it is hardly delicate enough to ensure that the telescope is always brought to exactly the same position. This question is referred to again under the head of Levelling.

Field Standardization.—It has been usual to lay down a test base with a standard bar for the purpose of comparing and giving a value to the field wires. M. Guillaume, placing entire reliance on Invar wires, considers it enough to compare the field wires with the reference wires on a bay formed with a pair of ordinary measuring tripods. On the Semliki Base we had no standard bar, the reference wires taking its place, and a value being given to the test base by them. Had our field wires not behaved eccentrically, this comparison on the test base would probably have been enough; but when one of them began to show unequal behaviour, we carried out several comparisons on a bay of two tripods. This method has some great advantages. It takes a very short time in itself, which is a good thing both for the observers and for the comparison. It can be done without any delay, such as would be involved in returning to the test base, and at any time when the behaviour of a wire appears to call for re-standardization, and the steadiness of the tripods makes the result very reliable. In the absence of a standard bar, it is probable that this method is sufficient in itself.

Levelling.—Mention has been made above of the importance of levelling, and it has been suggested that the "levelling telescope" can hardly be accurate enough for precise work on account of its small size and that of the attached level. The results of the record of vertical heights kept by us show that something is wanting. By far the greater part of the levelling was done with this telescope, and though some of the fault may have lain with the big level, it is reasonable to suppose that the majority of it was due to the levelling telescope. The difference of height between the terminal pegs of a section obtained during the forward measure differed from that on the return by an average of 0·1 metre (this is excluding the terminal sections, where the level and staff were principally used), and throughout these same sections the total difference of height obtained on the forward measurement differed from that on the return by 0·4 metres.

On other bases levelling has been done with level and staff only. On those measured in Northern Rhodesia on the 30th Meridian, the level was set up to one side of the base, and the staff placed successively on all the tripods in position at the time. Given a good instrument, carefully adjusted for collimation error, differences of level can be obtained thus with a high degree of accuracy and a little loss of time, and though it would perhaps be convenient to have one man told off for this work entirely, this is by no means essential.

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On the Semliki Base we used the levelling telescope on all normal ground, and the level and staff for terminal reaches and steep slopes. For work of this kind a good large level should be taken, say a 14″ Cooke, one light 10′ staff, and one 5′, both with a circular spirit level attached near the bottom end. It would be convenient if the staves were divided in metres, tenths, and hundredths, with a scale on the opposite side divided in some arbitrary manner, say into sevenths and seventieths. As a check reading, the staff is simply turned round, and not upside down.

Invar Wires.—The steel alloy known as Invar, and Invar wires themselves, have now been subjected to a long series of exhaustive tests, extending over many years, at the "Bureau International." Invar wires are being used at the present time all over the world for the purpose of base and other measurements.

Of the six wires used by us, four gave absolutely consistent and reliable results. The fifth appeared inconsistent, but I now hear from M. Guillaume that on re-standardization an error has been discovered in the formula for its coefficient of expansion; when rectified it is expected that this wire will prove to be in harmony with the others. The sixth however gave trouble. It was one of the three taken out in 1907 by the Boundary Commission, and from the outset appeared to have a different value to that given to it at Paris. On the Semliki Base this same wire gave variable results, and was considered untrustworthy.

In the criticisms which have been directed against the use of wires (as compared with tapes), the danger of twisting has been somewhat insisted upon. This danger is, I think, exaggerated. Any twist would probably be very noticeable long before it was serious enough to affect the length of the wire. The rolling and unrolling of the wires on the drum is an absolutely simple matter.

On the other hand, there can be little doubt that Invar wires as constructed are very fragile, and it would appear to be a matter for consideration whether it would not be worth while to increase their sectional area. An increase of diameter of, say, 50 per cent. would more than double their strength, probably without impairing any of their advantages as wires, while at the same time giving them a factor of safety which would relieve observers of a good deal of anxiety when using them with unskilled assistants.

Lastly, it should be noted, especially by those who have occasion to order these wires, that Invar is by no means always "invariable.' The coefficient of expansion is different for every batch of the alloy turned out, and it should be particularly specified that wires supplied should have as low a coefficient of expansion as possible. For this reason it is advisable to place orders early, otherwise one has to take what one can get.

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For example, the six wires used on the Semliki Base had the following actual expansions per 1° C. :—

		Mm.		Millionth.
168, 174	... ...	·0025		0·10
176	... ...	·01	equivalent to	0·41
119, 120, 121	... ...	·02		0·82

Compared with the expansion of ordinary steel, which is some 6·25 millionths, even that of the last wires appears small. But the whole point of using Invar is that the question of temperature shall be rendered unimportant, and when the expansion is near one-millionth per degree centigrade, the question of temperature is by no means unimportant.

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TRANSCRIPT.

AERIAL NAVIGATION AND THE WRIGHT AEROPLANE.

From the *Rivista di Artiglieria e Genio* of April, 1909.

UNTIL the year 1896 we advocated, in this Review, aerial navigation by means of heavier-than-air machines, which, though based on the flight of birds, would be modified by mechanical means so as to make up for the instinct with which the bird itself is endowed.

A balloon can always be sure of alighting slowly, provided that it does not catch fire or is not struck by lightning. The lifting power of the gas is always a good guarantee, whereas a machine, without this to rely upon, falls like a dead body to the ground, if suddenly arrested in flight.

If a flying machine has its motor paralyzed, it can glide slowly to earth with its planes sustaining it like a parachute, provided that the aviator keeps his head and is sufficiently expert, and also that the planes themselves are not damaged. In the same way as a good pilot in bad weather may often succeed in bringing a damaged ship into port, the aerial pilot may bring a damaged aeroplane safely to the ground.

The number of those who favour the dirigible balloon has increased during the last century, and many models have been experimented with. Amongst others are those of Blanchard in 1789, of General Meusnier in 1784, of Zambecazi in 1804, of Giffard in 1852 and 1855, Dupuy de Lorne in 1872, Tissandier in 1883, Capt. Renard in 1884 (la France), Count de Schio in 1905 (Italy), and Santos Dumont, who proclaimed in his book, *Dans l'Air*, that the gas dirigible is the flying machine of the future. And towards the end of 1905 the dirigible balloon designed and constructed by the engineer Julliot, and by the energy and munificence of the brothers Lebaudy—from whom it takes its name—performed marvels at Toul, showing itself obedient to the rudder and safe in the hands of the pilot Juchmés.

Whilst France rang with pæans of praise at the astonishing results obtained with the Lebaudy dirigible, there came a wonderful report from America. The brothers Orville and Wilbur Wright, manufacturers of bicycles at Dayton (Ohio), had carried out evolutions in the air with an aeroplane of their design and construction, furnished with a motor of 16-H.P.

This rumour gave a fresh impetus to those who favoured the heavier-than-air machines, and even Santos Dumont abandoned his principles by constructing a helicopter and studying an aeroplane.

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A number of aviators, especially in France, sought to imitate the brothers Wright, but only Farman and Delagrange succeeded in competing with Wright and in disputing with him the dominion of the air. The apparatus of all three was somewhat similar, being based on a cellular system, with motors varying from 25-H.P. (Wright) to 100-H.P. (Farman). The aeroplanes themselves are made as light as possible, the frames being covered with fine canvas and consisting of two superposed horizontal planes.

The brothers Wright employed from the commencement (1900) an apparatus with superposed wings, and experimented with it from 1900 to 1903. On the 17th December, 1903, they experimented with a machine fitted with a motor of 16-H.P., and succeeded in remaining in the air for 59 secs., travelling 260 ms. against a wind of a velocity of 32 kms. per hour. In 1904 more than a hundred flights were made at Dayton with a second aeroplane and motor, with which they were able to accomplish closed circuits and some variable courses, ranging up to 40 kms.

In these trials the Wrights sought to eliminate any difficulties that might arise by modifying the parts of the machine affected. Afterwards they made new trials for courses of short duration in 1905, keeping secret the working and details of their machine.

Towards the end of September, 1905, the aeroplane could be directed with a certain security and stability, and being improved upon from time to time, was able to make flights with the results shown in the following table :—

Dates.	Distance Travelled. Metres.	Time.	Cause of Stoppage.
26th September.....	17,961	18 mins. 9 secs.	Deficiency of fuel.
29th ,, ...	19,570	19 ,, 55 ,,	,, ,,
30th ,, ...	Not measured	17 ,, 15 ,,	Heating of the motor.
3rd October	24,535	25 ,, 5 ,,	,, ,,
4th ,, ...	33,456	33 ,, 17 ,,	,, ,,
5th ,, ...	38,956	38 ,, 3 ,,	Deficiency of fuel.

The last table shows a result of a velocity of more than 61 kms. per hour.

The machine used weighed 420 kgs., including the aviator, and a motor of 16-H.P. at first, and 25-H.P. afterwards. The distance travelled was measured with a Richard anemometer attached to the machine and verified by land when possible. The time was measured with accurate chronometers.

In February, 1908, the American Minister of War ordered a competition in the construction of aeroplanes under the following conditions :—

"The machine to be sustained in the air by dynamical means without the employment of gas.

"It should be able to carry two men, or about 160 kgs. of weight, with

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a sufficiency of fuel to run 200 kms. at an average velocity of 64 kms. per hour (40 miles) in calm weather.

"The price of purchase will be increased 10 per cent. for each mile (1,609 ms.) exceeding the above velocity per hour, and diminished in the same degree for each mile less than the above, provided that the average velocity is not less than 58 kms.

"The velocity will be measured above a closed course of 16 kms., the machine remaining in the air for an hour without touching the earth.

"To facilitate its use the machine should be transportable, and it should be possible to put it together and to ascend in less than an hour."

The conditions were somewhat onerous, but in spite of this there were 41 competitors, among whom were Scott of Chicago, price 25,000 lire (5,000 dollars); Heming of New York, price 100,000 lire; the brothers Wright of Dayton (Ohio), price 125,000 lire.

Orville Wright took part in the trials at Fort Meyer, commencing with short flights, so as to show the perfect working of the aeroplane, while Wilbur Wright made his trials at Le Mans, in France.

Orville Wright performed the following flights at Fort Meyer:—

9th	September,	1908:	57 mins. 28 secs.
9th	,,	,,	1 hr. 3 mins. 15 secs. at about 45 ms. above the ground; distance flown, 63·9 kms.
9th	,,	,,	5 mins. 38 secs. In the aeroplane were O. Wright and F. P. Lahm; 6·4 kms.
10th	,,	,,	1 hr. 5 mins. 52 secs.; 19·3 kms. (retarded by the wind).
11th	,,	,,	1 hr. 10 mins. 50 secs.; greatest height above ground, 60 ms.
12th	,,	,,	1 hr. 15 mins. 25 secs.; record of distance, time, and height.
12th	,,	,,	9 mins. 6 secs.; record for aeroplane carrying two persons.

It seemed certain that the Wright aeroplane would easily win the prize for the competition, having surpassed the prescribed velocity and time, but on the 17th September the trials were cut short by an unfortunate accident, in which Orville Wright broke his left leg and two ribs, whilst Lieut. Thomas Selfridge, who accompanied him, was killed by the fall. The accident seems to have been caused by the use of a screw propeller of too large a diameter.

While the aeroplane was in full flight the screw fouled the ligatures of the rudder. A sharp and unexpected roll of the machine immediately resulted, disturbing its equilibrium and precipitating it to the ground.

After this unfortunate accident Wilbur Wright modified the propeller and other parts of the mechanism of his aeroplane and accomplished great successes in France, winning honours and prizes in the face of rivalry, jealousy, and distrust.

During his trials he recognized that it was not necessary to use a motor of great power, having made an ascent with a 25-H.P. motor when carrying a weight of 450 kgs., viz., a passenger and 50 kgs. of benzine.

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The motor used by Wright had not any speciality, being of the same type as that used in automobiles. He used four cylinders lined with aluminium, water circulation 108 mms. in diameter, automatic valves, the usual method of ascent, automatic lubrification with circulation of oil produced from a pump.

The admirable speciality of this machine consisted in the torsion of the wings, which increased or diminished the angle of incidence according to the direction of the movements. The machine could be inclined and could fly like a bird, and it could be raised or lowered with ease and with perfect lateral equilibrium. After introducing several improvements in his machine, on the 10th September, 1908, he effected a flight under the best conditions, lasting 21 mins. $43\frac{2}{5}$ secs., with a velocity of 60 kms. per hour, not however surpassing his brother, who remained in the air for 1 hr. 15 mins., nor exceeding the French record held by Delagrange of 29 mins. $55\frac{4}{5}$ secs. (8th September in calm weather).

On the 21st September W. Wright gained the record for time and distance by a flight of 66·6 kms. in 1 hr. 31 mins. $25\frac{4}{5}$ secs., while he still had a good reserve of benzine and the machine in the best condition. On the 25th September he made three flights in the same day, in the last one having a passenger for 9 mins. 11 secs. On the 28th September he first of all went up alone, and remained in the air 1 hr. 7 mins. 24 secs., and afterwards, with Paul Tissandier and De Lambert, made other flights, the first of 11 mins. 35 secs., and the second 7 mins.

On the 30th September W. Wright won the prize of 5,000 francs of the Aero Club of France, having flown 42 kms. in 43 mins. on the 29th September, and 34 kms. in 35 mins. 36 secs. on the following day.

The victory of W. Wright was crowned by a good report of the condition of his brother, who was making satisfactory progress towards recovery at Washington, and who had obtained from the American War Minister an extension of nine months for the trials before mentioned.

EDWARD T. THACKERAY.

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REVIEWS.

HYDRAULIC TABLES AND DIAGRAMS FOR PRACTICAL ENGINEERS.

By CAPT. A. ff. GARRETT, R.E.

In this work, ingenious, practical, and clear, Capt. Garrett has added to his already high reputation as a scientific engineer, and he has earned the gratitude of many, not so much in the Army as in civil life, who have to design waterworks of all kinds.

The letterpress is clear and concise. It omits the discussion of fundamental principles, as these are certainly already known to those who are likely to use the work, but it gives in tabular form all information about units of area, volume, length, discharge, and pressure. A chapter is devoted to the subject of orifices, and the velocities at various heads for orifices of certain forms are given in tabular form, likely to be extremely useful to the engineer who may have to decide half-a-dozen times in the course of his morning's work the size of an outlet to discharge a given quantity.

Next comes a chapter on weirs of various forms. This is a matter on which there is much difference of opinion. Capt. Garrett does not commit himself to any predilection for the **V** notch over the rectangular, but gives tables of discharge of right-angled **V** notches and diagrams for weirs, both with a free fall and when "drowned."

As a rule the formulæ for such discharges deal with sharp-crested weirs only. But in actual practice the weir crest has to be made of some definite breadth, a fact which has a retarding effect on the discharge. Again in any flowing canal the velocity of approach must be practically considered, and although this is not ignored in recent formulæ, it complicates the calculation, which is already somewhat troublesome. Capt. Garrett's ingenious diagrams enable all these complications to be read off easily.

Possibly in some future edition the author may be able to give diagrams for **V** notches, or trapezoidal notches, with tip falls, such as are largely used on canals in North India, and which have given excellent results with varied depths of water.

The sixth chapter deals with the flow of water in pipes, asphalted, incrusted, and riveted. Attention is drawn to the most recent of the many formulæ dealing with frictional resistance, viz., that of Professor Unwin, which however differs only slightly in its practical results from the more widely known formula of Fanning. Diagrams based on Unwin's formula

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give in a graphic and most ingenious manner the velocity, discharge, and head per thousand feet for pipes of various diameters, under various conditions. There is also a very neat diagram giving the thickness and weight of cast-iron pipes of various diameters, and the head which may be reckoned safe at each thickness.

Chapter VII. deals with a subject little touched upon by the irrigation engineer, but most useful to a municipal surveyor, viz., the dimensions of sewers of various shapes. Diagrams based on Kutter's formula with the coefficient for glazed pipes in good condition, or for ashlar or well-laid brickwork, are given for sewers of different varieties and flowing just full. By means of coefficients given in tabular form, the discharge and velocity at varying depths are derived from the diagrams by a very simple calculation.

Chapter VIII. deals with the most difficult problem of all—the discharge in open channels, with the four variable factors of discharge and velocity, bed width, depth of water, and slope of bed. If any three of these are given, the fourth can be found from Capt. Garrett's diagrams, or if only two are given (such as the discharge and the bed slope), an almost infinite variety of values of the other two may be found to satisfy the conditions.

The diagrams are extraordinarily ingenious. With the aid of them the engineer who is working out, perhaps under great difficulties and under high pressure for time, the bed widths and depths of channels for various slopes and discharges, can do so by simple inspection, and can choose among several solutions the one that suits best the local conditions. It is also possible to see whether the decision will be affected by the "critical velocity," *i.e.*, that which will just carry silt in suspension without depositing it. The diagrams may also be used to ascertain the values of the important coefficient N in Bagin's formula in any doubtful case, and by utilizing the diagrams in connection with tabular statements, trapezoidal channels of various side slopes can easily be designed.

The admirable and most ingenious book contains in small compass a mass of practical information useful to all hydraulic engineers, but especially to irrigation officers. The writer can only say that if he had had a book of this sort on his office table when on works in India, many a weary calculation would have been saved and possibly many mistakes avoided.

G. K. SCOTT-MONCRIEFF.

THE BOARD OF TRADE RAILWAY CONFERENCE.

(Blue Book, Col. 4677, 1909. Price 1s. 5d.).

This report is important to those concerned in railway matters, and in view of the present movement towards state-ownership it is interesting to everyone. The Conference was constituted in February last year to discuss some of the more important questions which have been raised between railway companies and traders; both sides were represented.

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Of the disputed questions, an agreement was come to on the following :—

(1). A form of procedure for settling disputes that should be simple than that of the Railway and Canal Commission.
(2). That companies should have the power to restore rates temporarily reduced.
(3). With regard to "owner's risk" rates, the companies agreed to somewhat modify their attitude, and in certain cases to accept liability for "gross negligence" as well as for "wilful misconduct."
(4). A model private siding agreement was drawn up.
(5). A similar agreement for working of private owners' wagons.
(6). A procedure by which companies may acquire land. The present statutory powers involve needless expense; the average paid-up capital, £56,000 per mile of open line, so much in excess of the average in other countries, is attributed to this.
(7). The question of railway amalgamations, combinations, and working agreements was widely discussed, and a number of reports are printed giving the views of twelve members of the Conference; the subject is returned to, on the historical and legal aspects, at the end of the book. No agreement was arrived at.

Enquiries were made into the system of working foreign railways; the Blue Book contains the report of the two investigators sent to Germany, and other reports may be expected. The enquiries deal with :—

(A). The financial conditions under which privately-owned railways passed into the possession of the State.
(B). The control Government now exercises over the railways still in private hands.
(C). The composition, function, and actual working of the Advisory Councils.
(D). The extent and effect of competition with private-owned and Government lines.
(E). The rates systems.
And various other questions—liability for loss, private sidings speed, workmen's trains, demurrage, etc.; in fact, the extent of the enquiry was exceedingly wide.

The following is an abstract of the more interesting points dealt with, lack of space preventing the consideration of more than a few.

In Germany the privately-owned lines were purchased by degrees and at prices governed by the market quotations; legal powers existed for purchasing at other and sometimes lower terms, but these were ignored. A start was made in 1872 and the process is not yet complete.

The financial results can be judged by the interest earned in capital. In 1882 the State-owned capital was 4,379 million marks (the mark is about a shilling), and the earnings were 5·22 per cent.; in 1906 the

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capital had increased to 9,500 million marks, and the earnings were 7·48 per cent.

The capital cost per mile averages £21,469 (compare with the above-quoted £56,000 on English railways), and there are 35,400 kilometres (22,000 miles) now open. The low cost is partly due to lighter construction charges, low platforms, and the absence of over-bridges. The taxation is local and only £46 per mile; on the other hand, the railway administration is compelled to run postal services at a loss, and to fix rates from a standpoint other than mere revenue earning.

The control of the railway is through the Minister of Public Works, a permanent salaried official. He has extensive administrative and spending power, subject of course to the annual Parliamentary estimates. There are in addition various supervisory authorities and an annual General Conference.

For executive control the Prussian railway system is divided into 21 districts, each with its President and Staff. To determine rates the District President is assisted by a local Advisory Council, with members nominated by the Chambers of Commerce; similarly there is a General Advisory Council to assist the Minister. These councils can exercise considerable moral pressure and their recommendations are generally followed; but they have no executive power. From a railway point of view, they are useful because, through them, the railway is able to point out technical difficulties to the trade, and to shift on to other shoulders a certain amount of responsibility.

The tariff system is based on kilometric rates, which may be either "normal" or "exceptional." The normal rates are either per ton in wagon loads or per ton as piece goods. The wagon-load rate is for 5-ton or 10-ton wagons, and is cheaper than the piece-goods rate; it leads to a good deal of discontent, because the railway administration is often unable to provide trucks with suitable capacity. The monopoly of single ownership has in fact resulted in scarce rolling stock, or, as the railway would probably put it, economically-used rolling stock. Regulations impose demurrage after a much shorter time than in England—generally from 12 to 24 hours, but sometimes as little as six are allowed—and economy of working is obtained by giving an ample time allowance for rail transit, thereby ensuring full train loads. (In England the railway as a rule makes no guarantee; but in Germany the maximum transit periods are for "fast" goods 1 day + 1 day for each 300 kilometres, and for "slow" goods about double; and for delay they pay compensation on a fixed scale).

The piece-goods rate may be for either "general class" or "special tariff" goods, and for "fast" or "slow" services; it diminishes as the distance increases. As an example:—"General class" goods for slow services would be charged 11 pfennigs per kilometre (2¼d. a mile) per ton for from 1 to 50 kilometres, and 6 pfennigs if over 500 kilometres. For "fast" services the charge would be double. Terminal charges, 1 to 4 pfennigs a ton, are additional. "Special tariff" goods travel cheaper.

The "exceptional" rates have been getting more and more common,

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and now apply to nearly $\frac{2}{3}$ of the whole quantity. They are *reduced rates*, intended:—

(1). To advance internal industries.
(2). To assist native products in export.
(3). To support industries against imports.
(4). To support the railway against sea or other competitive transport.

They are complicated, as might be expected. For instance, 21 kilometre-ton rates are given for the same description of iron and steel goods, the differences depending solely on origin and destination. Again, the ordinary rate between Cologne and Hamburg for iron plates, railway locomotives, is 1·61 marks per ton; the export rate is only ·56 marks.

No direct comparison has been made with English rates, but a list of "iron and steel" rates is given from which one can be made.

The German rates for "iron and steel special Tariff I.," corresponding to our "iron and steel Class C," are "normally" 4·5 pfennigs per ton per kilometre between 100 and 200 kilometres, and "exceptionally" 2·8 or even less. These are equivalent to about ·9d. and ·56d. per ton per mile respectively for a distance between 62 and 124 miles. There is an additional charge of 1s. 3d. a ton for "terminals," and probably 5s. 6d. would be paid for cartage. Over a distance of 82 miles, as from Rugby to London, the German rate for rail transit would be "normally" 6s. 1d., and "exceptionally" 3s. 10d., or adding the charges for terminals and cartage, 12s. 10d. and 10s. 7d. respectively. In England the rate for this journey is 12s. 3d., including terminals and cartage; there might be an "exceptional" rate as well, but in England they are less common, less extensive in amount, and are only put on to assist the railway against competition. There is not much to be said for either on the score of simplicity.

Agriculture is more favoured in Germany; for instance, to Portsmouth from London the charge for potatoes would be 3s. 4d. a ton instead of 11s. 3d. In Germany there are no rates such as ours which include loading and unloading, collection and delivery; and the agents performing these services are independent of the railway administration. A large trader does his own work, but the usual thing is to leave it to one of the "spediteur" companies; they charge from 2·50 to 3 marks per ton for collecting and delivering near a town.

The "spediteur" serves a useful purpose in addition as a forwarding agent. The complications of tariffs require expert knowledge, and merchants generally entrust the whole business to the "spediteur"; he not only looks out the best routes and tariffs, but is often able to combine goods from different senders and obtain a cheaper wagon-load rate than would be possible with separate parcels. This is to the advantage of railway merchant and "spediteur" alike; we in England have something of the same sort of thing in the transit stores now commonly found at big junctions, but the inducements and facilities are less.

More than half the Blue Book (90 pages) is taken up with this account of the German State Railways.

R. H. Cunnington.

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THE TIMES' HISTORY OF THE WAR IN SOUTH AFRICA.

VOLS. VI. AND VII. (THE LAST OF THE SERIES).

Part I. deals with the work of reconstruction during and after the war, with a brief survey of political events down to the spring of the present year.

In Part II. are described the measures necessitated from the commencement of hostilities to place the whole army in the field, equipping and maintaining every branch.

A mass of information has been carefully collated with regard to Sea Transport, Railway Work, Supply and Transport, Medical Services, Ordnance and Artillery, etc. The various branches of Engineer work throughout the whole theatre of operations are referred to and the increasing importance of the Engineer in war is insisted upon.

The value of the "Fourth Arm"—the Engineers—is emphasized, and attention drawn to the "danger of our forgetting how entirely dependent armies now are on their engineers."

It is satisfactory to note how highly the actual work done by the Corps is always referred to. On p. 333 we read that "some of the duties performed were conspicuous and obvious, but more were comparatively obscure, though none the less important because they lacked excitement and notice. An immense amount was done by the Engineers—Regular, Volunteer, and Civil—and no duties during the campaign were better or more conscientiously carried out."

Again on p. 338, . . . "the longer the war went on the more fully was the usefulness of the fieldwork of the Engineers realized. Divisional or column commanders who had never commanded Engineers, or at most only on manœuvres, at first hardly appreciated them or knew how to make use of them. . . . At the end of the war there was a continual demand for Engineers. . . . The conclusions most obvious from the experiences of the war were the need for a larger proportion of field Engineers to other troops and for having a larger number of the Engineers mounted."

More recent experience from the Russo-Japanese War adds yet another conclusion, namely, the necessity of having a sufficiency of Engineer units trained for siege work, regarded but a few years before as likely to be obsolete.

Last but not least in importance, a chapter has been devoted to Finance.

Useful lessons of the war are deduced under the respective subheads in the several chapters.

Much has been done in reorganization of late years to fill the gaps, but many may still ask whether, *as a nation*, we have really taken the lessons of recent war to heart, and even now done enough to meet the future needs of an army which cannot be anything but Imperial, if the Empire is to stand?

The illustrations are confined to portraits of individuals—both military and civil—who took a prominent part in the campaign.

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The Index of the series is contained in a separately bound volume, which is numbered VII.

The editor, L. S. Amery, deserves the thanks of the general public and congratulations on the completion of a nine years' toil. His work is a classic.

AN INTRODUCTION TO MILITARY GEOGRAPHY.

By BRIG.-GENERAL E. S. MAY, C.B., C.M.G.—(Hugh Rees, Ltd., 119, Pall Mall. 8s. 6d. net).

This book of some 250 pages is divided into 13 chapters, dealing in turn with Artificial and Natural Frontiers; Some European Frontiers; The Influence of Geographical Features in Operations; The Sea in Relation to Operations of War; Lines of Communication; Canals and Waterways; Strategical Railways in Process of Construction; and chapters on Persia, Afghanistan and the N.W. Frontier of India, Abyssinia and Manchuria.

In an introductory chapter Colonel May gives various reasons why officers should study geography, pointing out its influence on war both as regards the resources, weather, lines of communication, etc., of the country in which operations are to take place, and recalling how lack of knowledge in the military geography of South Africa lead to increased difficulties in the operations there.

The whole book is extremely interesting, is full of well-chosen examples emphasizing the various points referred to, and contains as well numerous maps, each carefully chosen to illustrate some special lesson.

The strategical railways in progress of construction include those of the Balkan Peninsula, the Baghdad Railway, the Damascus-Hedjaz Railway, the Amur Railway, and the Northern Nigeria Railway.

The two chapters on Persia and Afghanistan and the N.W. Frontier of India are of particular interest to Sappers, as so many of the Corps have been employed at different times in these regions.

Finally, three interesting appendices are given, consisting of the terms of the Convention of the United Kingdom and Russia relating to Persia, Afghanistan, and Thibet; the Anglo-Japanese Agreement; and the record of a unique achievement of cavalry and horse artillery rendered possible by climatic conditions in 1795.

Also Received.

STRATEGY OF THE RUSSO-JAPANESE WAR.

By BREVET MAJOR W. D. BIRD, D.S.O.—(Hugh Rees, Ltd., 119, Pall Mall. 4s. 6d. net).

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NOTICES OF MAGAZINES.

ELECTRICIAN.

July 2nd, 1909.

INCANDESCENT LAMPS.—Mention is made of 16-C.P., 210-volt, 25-watt lamps made by the Stearn Electric Lamp Company. The consumption of energy is higher than that of most metallic filament lamps (1·6 watts per C.P., as against 1·1), but the bulbs are small and the filament is more robust. No figures are to hand as to life. The lamps will be on the market in two months' time.

ELECTRIFICATION OF BADEN STATE RAILWAYS.—Brief description is given of the electric locos. It was decided to utilize existing rolling stock and construct locos. with six driving wheels coupled. Two single-phase commutator motors drive the coupling bar by means of connecting rods inclined to horizontal at an angle of 60°.

WIRELESS TELEGRAPHY.—Illustrations are given of various portions of Telefunken apparatus described in *Electrician* of 18th June, 1909.

RADIO-TELEGRAPHY.—Continuation of Professor Fleming's lecture to the Royal Institution. Oscillation detectors dealt with in some detail.

ELECTRICAL DEVICE FOR SOLVING EQUATIONS, ETC., is described, which is said to find even imaginary roots of numerical equations correct to within 1 per cent. For full description see papers of Physical Society.

ELECTROLYTIC DISINFECTOR for laundries or hospitals is described briefly. They are largely used in German hospitals.

July 9th, 1909.

ELECTRIC TRACTION.—Articles by Mr. Dawson are continued, No. XVI. dealing with collectors for overhead conductors.

RADIO-TELEGRAPHY.—Conclusion of Fleming's lecture.

PURIFICATION OF RIVER WATER BY OZONE.—For purifying water which has been contaminated by sewage, ozone is now being used in many places. In Paris Siemens Halske ozonizers are in use. The process takes 133 electrical units per million gallons of water treated, but further

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plant is to be installed, taking 315 units per million gallons. The results obtained are said to be satisfactory.

METALLIC FILAMENT LAMPS.—Other lamps by Ediswan of lower candle-power and with smaller-sized bulbs are mentioned.

July 16th, 1909.

"FLICKER" TYPE PHOTOMETERS.—Doubt is thrown on the accuracy of candle-power of metallic filament lamps when measured by this instrument. This type appears to make the C.P. 6 per cent. too low.

ALTERNATORS FOR WIRELESS TELEGRAPHY.—Description of an alternator for 100,000 cycles per second, as developed by Fessenden for wireless telegraphy. It has an output of 2 kw. at 110 volts, and runs at 20,000 r.p.m. The revolving disc which contains the field magnet system is made of chrome nickel steel with an elastic limit of nearly 100 tons per square inch.

ELECTRIC TRACTION.—A continuation of Dawson's articles, dealing with overhead collectors.

ELECTRICITY SUPPLY OF CHICAGO.—The chief points of interest are :—

(1). The plant is modern, the oldest part dating to end of 1903.
(2). The enormous size of the undertaking.
(3). It is an excellent example of the relative spaces taken by boilers and prime movers of modern design.
(4). The fact that 14,000-kw. generators are to be installed.

STREET LIGHTING IN CONTINENTAL TOWNS.—Report of a deputation from the Corporation of London which has been abroad recently. The practice in many continental towns is reported. The general conclusions are :—

(1). Where possible streets should be lighted by means of centrally hung lamps with lowering gear.
(2). Open spaces should be lighted by lamps upon standards, and fitted with lowering gear.
(3). High-pressure incandescent gas lamps with inverted burners should be adopted as illuminants. Where gas is impracticable, electricity with arc lamps should be installed.

The "Graetzin" high-pressure lamp is described. A 4,000-C.P. lamp gives about 50-C.P. per cubic foot of gas—it is not stated if this is result of experiment or maker's claim. The mantles are renewed every nine days.

July 23rd, 1909.

ELECTRIC TRACTION.—Article XVII. deals with the feeders and feeder system.

ELECTRICITY SUPPLY OF CHICAGO.—PART II.—The staff required is detailed. With modern plant this is very small.

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ANTENNÆ FOR WIRELESS TELEGRAPHY.—The different forms found in practice are discussed. Those which are directional, *i.e.*, receive or send better in one direction than another, are detailed. The best forms of earths are also mentioned.

SHORT DISTANCE RAILWAYS.—Notice of 1,200-volt continuous current equipment.

An account of another electro-magnetic method of solving algebraical equations is contained in this number.

A. E. DAVIDSON.

JOURNAL DES SCIENCES MILITAIRES.

July 1st, 1909.

FRENCH MANŒUVRES, 1908.—The opening article is on the French manœuvres of 1908, written by a Russian staff officer. Having just previously been at the German manœuvres in Alsace Lorraine, he compares the two, and on the whole considers the German manœuvres to be the more practical. Although they only lasted four days as against the French nine, operations in the latter ceased each day at noon and practically did not recommence till next morning. This of course was striking at the chief end of manœuvres—their resemblance to real warfare. Theoretically they were supposed to recommence at sunset, but no attempt was ever made by either side to operate in the evening. This was no doubt due to the habit of always sleeping in a cantonment. Another mistake was that the troops always knew where the director of the manœuvres would be, and operations were involuntarily keener at this place.

On one side a cavalry corps on the German model was formed. It was only moderately successful. Its operations were marked by slowness, indecision, and lack of adaptability. A detachment was sent to seize a bridge, but finding it unoccupied passed over and left no garrison. On its return it found that the bridge had been seized by hostile infantry, which could not be forced.

The chief difference between French and German tactics is that the Germans invariably try to take the offensive, and turn one or both flanks, whilst the French insist on keeping their forces concentrated, and thus generally get indecisive results.

THE COMBINATION OF ARTILLERY AND INFANTRY.—This article is continued. For small forces such as a mixed brigade it is considered that artillery is unnecessary with the advanced guard. The main body will not be very far behind, and if needed by the advanced guard, a battery can soon cover the distance. Though it is laid down that artillery which is at all

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exposed should have a special infantry escort told off, this is by no means always done. Even when there is an escort, it is not under the orders of the artillery. A group of guns requires a company (200 men) or even two, but for a battery one section of 70 men should be enough.

Infantry attacking artillery should make for its flanks and rear. The horses, drivers, wagons, and limbers, are the objective. Artillery should fire, not on its own most important enemy, but on the enemy which is most troublesome to the army in general, whether it be the hostile artillery or the hostile infantry.

The knowledge possessed by artillery officers of the tactics of other arms is not of itself a sufficient basis for the necessary co-operation. How this combination is to be attained should be clearly laid down by regulation.

WAR.—A new book on "War" has been lately published by General Kessler. It is of course based mainly on the Russo-Japanese War. The review points out the entirely opposite "lessons" deduced by various people. Some think that this campaign was full of them, others hold that nothing new came out that had not already been foreseen by theorists. For instance, the French General Staff has made no important modifications in the latest edition of its "Conduct of War." General Kessler considers that superiority of fire should no longer be sought for, as it is manœuvring alone that gives victory. To manœuvre with ease, extended fronts and open order become necessary. This should be in favour of the French national characteristics, of bravery, intelligence, initiative, and independence, as opposed to the German strength, which lies in order, discipline, and cohesion. Some may doubt whether the German and Frenchman are really so different as is generally believed; but whether or not this is so, the national trainings are such as to accentuate the differences. It is true that many of the Revolutionary volunteers were by no means willing soldiers, but there must have been a large number of true patriots whose zeal and example stimulated the others to the great deeds they performed. To this is due the change of tactics of the time of the Revolution from the solid masses of former years. These masses were to prevent the desertion of the unwilling levies. The Revolutionaries however did not need such means, as patriotism and sentiment kept them from deserting. It is suggested that the supposed heavy losses in 18th century battles were really due to the wholesale desertions which took place as soon as the *serre-files* failed to exercise their usual pressure.

PROMOTION OF OFFICERS.—"A Colonel" writes on the promotion of officers. His three main points are that (1) promotion is almost entirely considered, and therefore awarded, as a recompense; (2), too much attention is paid to years and not enough to fitness; (3), too much attention is paid to distributing promotion evenly between the various army corps.

(1). In any promotion list the officers who are actually training the troops are passed over in favour of the staff, influential persons, and those who have passed good exams. The promotion list might be ticked off

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in the same way as prizes are awarded at a school—prize for memory, prize for recitation, prize for politeness, etc. No blame is to be attached to officers who try for these special billets, as it is the only way to get on. But promotion should be given instead to the men who have the gift of command. Each captain has enough responsibility to show whether or not he is fitted for promotion, and this should depend on the way in which he carries out his duties as captain. The same rule should also hold in the field; mere bravery should be rewarded by the Legion of Honour, never by promotion of an unfit man.

(2). A man is no older than he feels. Why retire excellent officers, perfectly fit in every way, because they happen to have lived a certain number of years, while others, who are quite useless, are allowed to remain on the active list because they are younger in years.

No doubt the scheme would be an excellent one if it could be carried out, but it is difficult to judge in many cases the fitness of a man. As regards the promotion, it would be almost impossible to ignore army corps, without raising bad feeling.

H. L. WOODHOUSE.

LE BULLETIN.

March 31st, 1909.

IMPERIAL GERMAN MANŒUVRES, 1908.—Carrier pigeons, carried in baskets strapped on the back, were used by cavalry. Special attention was paid to methods of communication, central communicating posts being formed, provided with motor cyclists.

April 15th, 1909.

FRENCH ARMY ESTIMATES, 1909.—The article includes a comparison of the French and German systems of promotion of officers.

COMPOSITION OF ORDERS IN LARGE UNITS describes the French system of supply for an army in the face of the enemy. Portions of supply and ammunition columns and field hospitals (corresponding to our tent division, field ambulance) are linked up to form an *échelon de combat*, which follows immediately behind the main body, and in front of all second line transport.

May 15th, 1909.

FRENCH ARMY ESTIMATES, 1909 (*continued*).—The question of the replacement of horse-drawn by motor-driven transport is discussed. It is noted that the only steps hitherto taken have been in the direction of replacing the transport between the railhead and supply columns, whereas it is more important to secure greater mobility in the supply columns themselves. By next spring each of the four fortresses on the east frontier will have its dirigible balloon. Dirigible stations are ready at Verdun and Belfort, and those at Toul and Epinal are under construction.

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FRENCH GRAND MANŒUVRES, 1908.—An account is given of the supply arrangements by motor transport between the railhead and advanced depôts.

May 31st, 1909.

FRENCH GRAND MANŒUVRES, 1908 (*continued*).—The special instructions given to the umpires are of interest. They include several conventions with regard to the counting value of troops, thus :—

Infantry on the defensive, entrenched = four times actual strength.
Infantry on the offensive, advancing by rushes = three times actual strength.

Of two bodies of infantry, both supported by artillery, that alone whose artillery is the stronger is considered as supported by artillery.

FOREIGN MILITARY INTELLIGENCE.—*The Present State of Aeronautics in Germany.*—At the end of the present year there will be four Zeppelin, four Parseval, and three Gross dirigibles in Germany. A school of aeronautics is to be formed at Friedrichshafey for technical instruction in aerial navigation.

'E.R.'

REVUE MILITAIRE DES ARMÉES ÉTRANGÈRES.

February, 1909.

MILITARY NEWS FROM VARIOUS COUNTRIES.—*Austria.*—The field artillery were re-armed on the 5th January, 1909, with a new 8-centimetre, 1905, field gun. The fortress troops have been reorganized by the Army Order of the 18th January, 1909. The fortress artillery now consists of 19 battalions (72 companies) arranged in six regiments, of which four have two battalions and two have three, and five independent battalions. A fortress balloon section and an electric lighting detachment are attached to each regiment or independent battalion. A fortress artillery company has 4 officers and 99 men, and a fortress balloon section 1 officer and 19 men.

The two first Austro-Hungarian military balloons, designed by Dr. Raymond Nimführ, an Austrian aeronaut, are in process of construction. The smaller will have a capacity of 1,500 cubic metres, and is intended to assist tactical reconnaissance; the larger, with a cubic content of 3,500 metres, is to be used for strategical reconnaissance. Mechanical draught is to be used by all field balloon detachments.

Belgium.—The construction of 11 forts and 12 redoubts, the new advanced line of the Antwerp defences, will be started on the 27th February, 1909. The cost of this undertaking will be 13½ million francs, and it will take 3 years and 3 months to complete.

Germany.—It is rumoured that the War Office intend to lend their heavy motor vehicles to private firms. The drivers, who are soldiers of the

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experimental section of the line-of-communication troops, will accompany the vehicles, and as the latter will be lent chiefly to agricultural firms, it is hoped that they will acquire a better knowledge of their cars than they could get if the latter were used for purely military purposes. The firms will only have to pay the cost of upkeep of the vehicles.

The garrison of Metz possesses an automobile ice safe for the distribution of meat to the various units in the station.

Practice against captive balloons is to be carried out in the spring of 1909, in the bay of Dantzig, by guns on special mountings. Last year's practice showed that projectiles from field guns and howitzers cannot hit balloons at a greater altitude than 1,200 metres; hence the new experimental carriages.

An experimental wireless telegraph station has been built at Göttingen. The masts are 85 metres high and weigh 6,000 kilogrammes. Similar stations may be erected at Cologne and Konigsberg.

United States.—The regular army increased in 1908 by 19,168 men, but is still 9,558 below the authorized establishment. The percentage of desertions has fallen from 7·4 in 1906 and 5·6 in 1907 to 4·6 in 1908.

The methods of teaching horsemanship in vogue in the French Army are to be taught at the U.S.A. cavalry school of Fort Riley (Kansas).

Italy.—The following are the principal points of the third report of the Royal Commission of Enquiry on the Army:—

(1). The administration of the army requires simplifying and decentralizing.

(2). The army corps commanders should take parts in the schemes of the Army Council and of the National Defence Committee.

(3). The strength of infantry companies, which at certain times of the year falls as low as 50, should be fixed permanently at 96 of all ranks.

(4). The strength of a squadron should be 130, the number of squadrons per regiment five instead of six, and the number of regiments would thus be increased from 24 to 29, and a new division of independent cavalry could be created.

(5). The peace establishment of a field artillery battery should be 90 men, 60 horses, and 4 guns, with an increase to 6 guns when on war footing. Horse artillery, 4 guns per battery. Mountain artillery, 6 guns. The raising of a new regiment of mountain artillery of 12 batteries is recommended.

(6). The changes recommended in the Corps of Engineers are:—

(*a*). The creation of a pontoon regiment, so as to relieve the pioneers of this duty.

(*b*). To transform the railway detachment into a regiment with three sections.

(*c*). To make the specialist section independent, *i.e.*, hand over wireless telegraphy to the telegraphists, and take away the automobile section from the railways and attach it to the specialists.

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(*d*). The raising of an independent detachment of engineers for Sardinia, consisting of one pioneer and one telegraph company.

The Commission next proposes to deal with the education and promotion of officers.

A. H. Scott.

The Railway Engineer.

April, 1909.

Reinforced Concrete Sleepers in America.—These have been tried by several of the railway companies, and have been found to be infinitely more lasting than timber. Those used by the Lake Shore and Michigan Southern Railway are made of lengths of old flange rails inverted and set in concrete. The running rail is clipped down to the sleeper, the clips being held down by nuts screwed on to the threaded ends of U-shaped straps running underneath the sleeper.

The sleepers weigh 400 lbs. complete. It is found that they form too rigid a bed for high-speed trains, but that they are excellent for slow speeds and for sidings, where they last a lifetime. The inverted flange rail protects them from being broken by the wheels of derailed trains.

Another form of sleeper is used on the Elgin, Joliet, and Eastern Railway. It is composed of two scrap boiler tubes, $2\frac{1}{4}''$ in diameter, slotted through at either end, a stiff sheet of wire being passed through the slot and the whole wrapped round with chicken fence wire, which binds the concrete together and prevents it from separating should the sleeper become cracked.

It was found that 20 per cent. of the sleepers thus made failed in use under the rail, and that 5 per cent. were broken by derailments. On this account the design was slightly modified. A pressed steel box was placed round each sleeper with a 2″ piece of wooden packing on top of the box, the rail being held down as described by U-straps and clip-washers.

It is thought that the failure of the sleepers mentioned above was largely due to their being made of inferior material and under insufficient pressure during manufacture. The cost worked out at 6s. per sleeper.

Another form of sleeper is in use in connection with the line from the Chicago and N.W. Railway to the Sioux City Stockyards Company. It is cross-shaped, one cross being placed under each rail and the pair being connected together by a tie. Each cross has an area of 4 square feet. Eighty-ton engines, drawing trains of 50 or 60 cars, pass over several times daily, and as the line is laid over an old marsh which is liable to be flooded in wet weather, the test is additionally severe. After seasoning for 18 months, the blocks are capable of resisting a blow of 30,000 lbs. per square inch.

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The same material is now being used on some of the Pennsylvania lines for telegraph poles and signal standards.

AUTOMATIC TICKET PRINTING MACHINE.—This machine, which is called the Regina Automatic Ticket Printing Machine, is engaging the attention of railway managers, and will shortly be manufactured in this country at Birmingham, where a factory is being built for the purpose.

Present methods of issuing tickets leave much to be desired, as they are both troublesome and expensive in operation. At big stations many hundreds of tickets have to be pigeon-holed, and to avoid all chance of their running short, excessive quantities have to be kept printed and in store. To safeguard against fraud, these have to be checked frequently, while the daily stocktaking and balancing is a wearisome operation, which sometimes takes as long as three hours to carry out.

The new apparatus consists of a table between 3′ and 4′ in length, whereon are tabulated the names of the different stations, space being provided for about 2,000 different names. A sliding carriage works, at the will of the operator, backwards and forwards over the length of this table. When a ticket is asked for a blank card is placed in the sliding carriage, which the operator slides along, opposite the name of the station required. The operator then presses a small lever at the right-hand end of the table; this prints the blank ticket in duplicate, with the station of departure and destination, date, route, luggage, district, class, price, and number. One of the tickets thus printed is handed to the passenger, while the other is retained as a record.

These machines have been in use in Cologne Central Station, and have been found so satisfactory that an order for more of them at a cost of £30,000 has been given by the State Railways. They are very compact and are made in various sizes, the cost varying from £100 to £350, according to size.

Besides issuing railway tickets, machines made on the same principle can be used for all similar purposes, such as theatres, places of amusement, steamboats, etc.

A. J. SWINTON.

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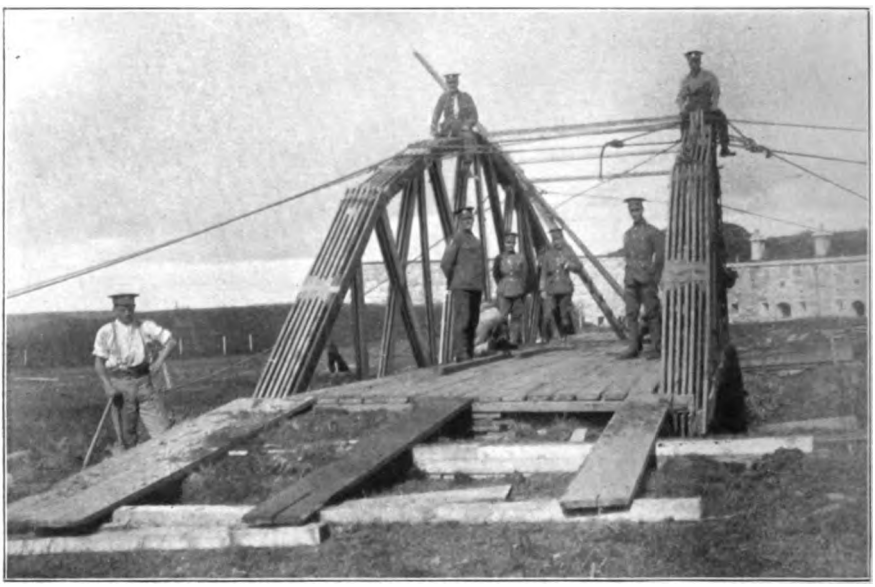
A PLANK GIRDER BRIDGE.



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A PLANK GIRDER BRIDGE.

By Lieuts. C. H. R. Chesney and C. O'R. Edwards, R.E.

In the August issue of the *R.E. Journal* there appeared a description of an improvised lattice girder bridge, made up of round spars and bar iron.

The author apologized in his article for offering an account of yet another bridging expedient, with the excuse that few accounts of improvised girder bridges had appeared of late, and the authors of this article feel they must offer a similar excuse for this description of a plank girder bridge as designed by them and constructed by the 20th Company, R.E.

Plank girder bridges have been constructed during more than one course at the S.M.E., but in most cases, as far as can be ascertained, the planks used in the main girders have been placed flat, instead of on edge, and bent to give the required form if the girder chosen was parabolic. Therefore it is thought that the following notes may be of interest and use.

The chief features advocated for this type of bridge are :—

(*a*). That planks and timber from roof trusses are far more likely to be obtainable by a siege company on service, than spars of any dimension.

(*b*). That bolts are also more easily obtainable than lashings, seeing that they can be constructed by the blacksmith of the unit from any bar iron in the vicinity.

The parabolic form of girder was chosen in preference to a lattice type, as the latter does not give the necessary height to allow for top bracing, unless it is so deep as to be out of proportion. This top bracing is exceedingly necessary in this form of bridge on account of the "whippiness" of the girders, which must obviously arise owing both to the absence of any continuous beam throughout its length or even for half its length, and also to their absolute independence of each other above the roadway.

The calculations can be easily worked out with the help of the formulæ given on pp. 188 and 189, *Molesworth Pocket-Book*. The diagram and sections give all dimensions and details, and the photographs show the bridge as completed.

In the construction, wooden chocks were placed between the planks in the middle of their lengths, and iron gabion bands nailed around.

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As a matter of fact, an extra F.S. of two was allowed in this case, and the bridge easily carried the weight for which it was calculated. The roadway, 9′ in the clear, was carried direct on the bottom boom.

As regards the practical construction and the launching of the girders into position, a few points are worthy of notice. Obviously all planks must be cut to the necessary length and marked before starting. The girders are then built up on their sides, according to the drawings, each joint being supported on little wooden piers, about 15″ high, made up of wooden chocks. When all the planks are in position, the bolt holes are driven through with augers. If enough long bolts are available for all the joints, it is a very simple matter to complete the girder by hammering the bolts through from above, but if, as was the case, short 5″ bolts had to be used for the verticals, and only one long bolt was available for each tension joint in the bottom boom, then the bolts must be driven through from underneath, after which sufficient planks must be taken off to allow the bolting of the verticals and the intermediate spiking (*vide* drawings of joints) to be carried out whilst rebuilding.

According to calculations, a 6″ overlap on each side of one bolt is sufficient in the bottom boom tension joints, but with timber of doubtful quality, as was actually used, it was considered necessary to add the spiking, seeing that the number of bolts could not be doubled, the danger being that the resistance to shearing of the timber was somewhat meagre.

In launching, the best way would appear to be to launch both girders together in a vertical plane, with all the necessary side guys attached. When across the gap, they can be easily got into the exact position by levering their ends sideways. If the girders are launched separately, their inner side guys will be found to interfere with each other.

As regards the weight carried, a concentrated load of $2\frac{1}{2}$ tons on a single pair of wheels was placed in the middle of the bridge. At another time about 60 men crowded in the centre, say 5 tons, was carried without any signs of deflection.

This form of bridge takes very little time to construct; 30 men should easily complete the whole bridge of 54′ span in one day, the materials having been collected on the site on the previous day.

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A PLANK GIRDER BRIDGE.

References :—

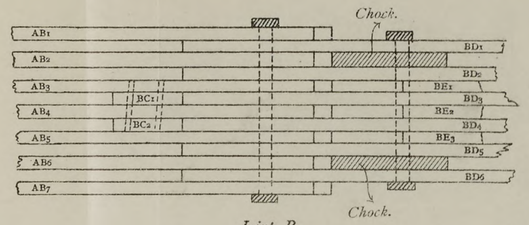
AB1, 2, 3, 4, 5, 6, *and* 7. } *Top Boom.*
BD1, 2, 3, 4, 5, *and* 6. } *Top Boom.*
DF1, 2, 3, 4, 5, *and* 6. } *Top Boom.*

BC1 *and* 2. } *Verticals.*
DE1 *and* 2. } *Verticals.*
FG1 *and* 2. } *Verticals.*

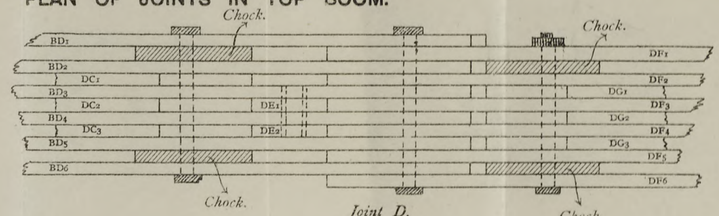
BE1, 2, *and* 3. } *Diagonals.*
DC1, 2, *and* 3. } *Diagonals.*
DG1, 2, *and* 3. } *Diagonals.*
FE1, 2, *and* 3. } *Diagonals.*

AC1, 2, 3, 4, 5, *and* 6. } *Bottom Boom.*
CE1, 2, 3, 4, 5, *and* 6. } *Bottom Boom.*
EG1, 2, 3, 4, 5, *and* 6. } *Bottom Boom.*

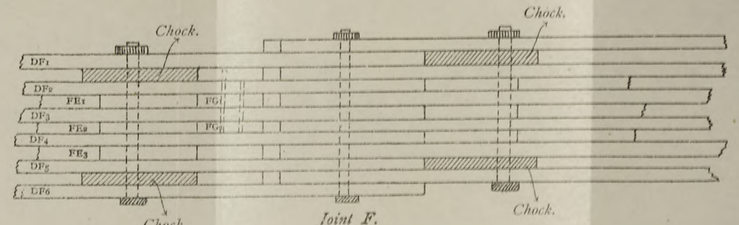
PLAN OF JOINTS IN TOP BOOM.



Joint B.



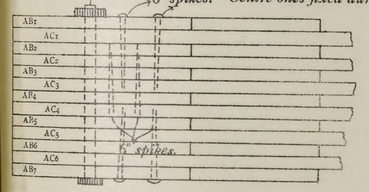
Joint D.



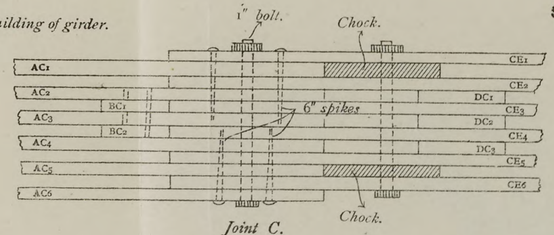
Joint F.

SECTIONAL PLAN OF JOINTS IN BOTTOM BOOM.

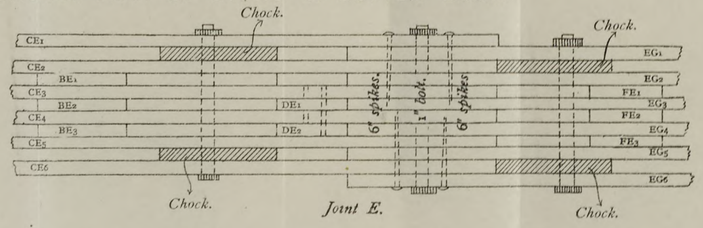
1" bolts. 6" spikes. *Centre ones fixed during building of girder.*



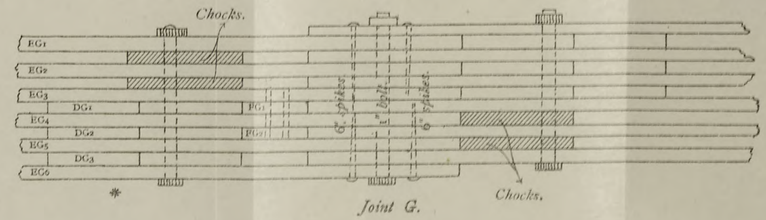
Joint A.



Joint C.



Joint E.



Joint G.

Sections taken 6" above bottom boom.

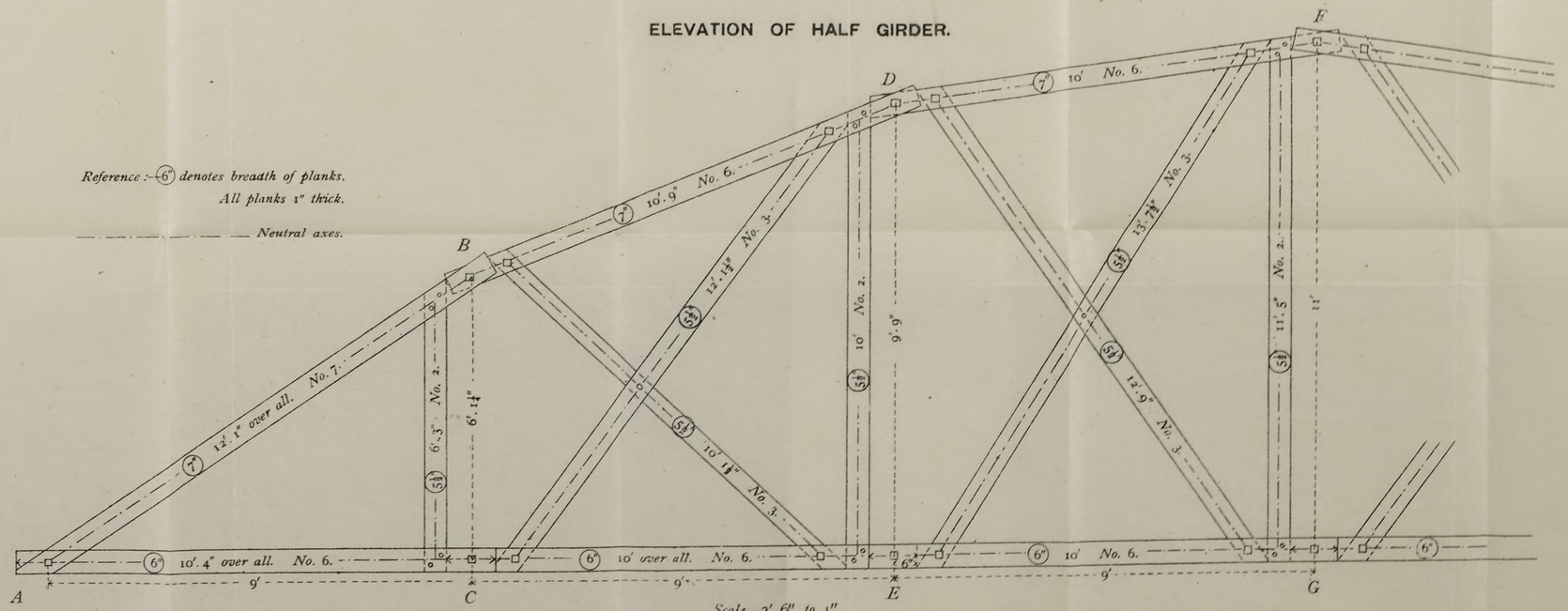
Scale— $\frac{1}{10}$

Inches. 12 9 6 3 0 1 2 3 *Feet.*

* *The necessity for the placing of these diagonal ends out of centre will be seen if the interlacing of the planks is followed out.*

All diagonals and verticals have a tilt of one plank thickness = 1" in their total length.

ELEVATION OF HALF GIRDER.



Reference :— (6") *denotes breadth of planks.*
All planks 1" thick.
——·——·—— Neutral axes.

Scale—2' 6" to 1"

Feet 2' 6" 1' 9" 6" 3" 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 *Feet.*

N.B.—All tension members in bottom boom have at least 6" overlap beyond bolt.
All bolts 1" in diameter, except those through verticals, two at each end, ⅞" in diameter.

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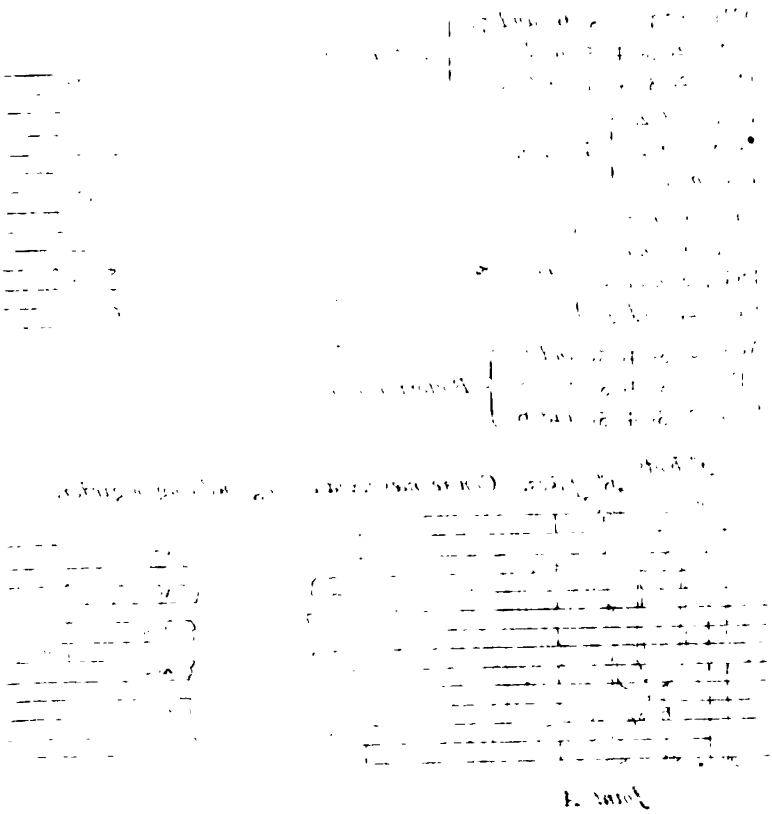

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AN EXERCISE IN FIELD TELEGRAPH TACTICS.

By MAJOR E. G. GODFREY-FAUSSETT, R.E.

WE have at present no manual of instruction in the methods of utilizing army telegraph units, and the following scheme has been worked out partly from theory and partly from practice during the training this year of the telegraph units at Burghclere.

Before going into the details of the work itself, it may be as well to state clearly a few axioms which should always be borne well in mind :—

1. The chief duty of *air line* is to keep the commander of a force in touch with his advanced base ; of *cable*, to keep him in touch with his divisions, and with such other bodies of troops as he may keep under his personal control. The divisional telegraph companies are concerned solely with the internal communications of the divisions, and are not referred to here at all. Wireless, as at present organized, is concerned solely with the communications of the strategical cavalry, and also does not come into the scheme.

2. *Inter-Communication.*—Troops are controlled by the Director of Army Signals, who receives orders from the Commander-in-Chief through the C.G.S. Similarly, for a detached force, an A.D.A.S. would probably be appointed, who would receive orders from the C.G.S. of the force.

3. *Army telegraphs* are constituted into units of air line and cable, called companies, but the exigencies of warfare would so often entail these units being split up, that it is better to consider them as sections, each under a subaltern, with two detachments in each section.

4. *A cable section* consists of two detachments, each containing 10 miles of cable, and two third-class (buzzer) offices. Each detachment is complete in camp equipment, and carries one day's supplies. *A cable company* consists of four sections and a ninth detachment belonging to headquarters. The headquarters includes spare men and horses, one major, and one captain.

5. *An air-line section* consists of two detachments, each containing 10 miles of air line, and two second-class (Morse simplex) offices. Each detachment is complete in camp equipment, and contains one day's supplies. *An air-line company* consists of three sections and a headquarters, including spare men and horses, one major, and two captains.

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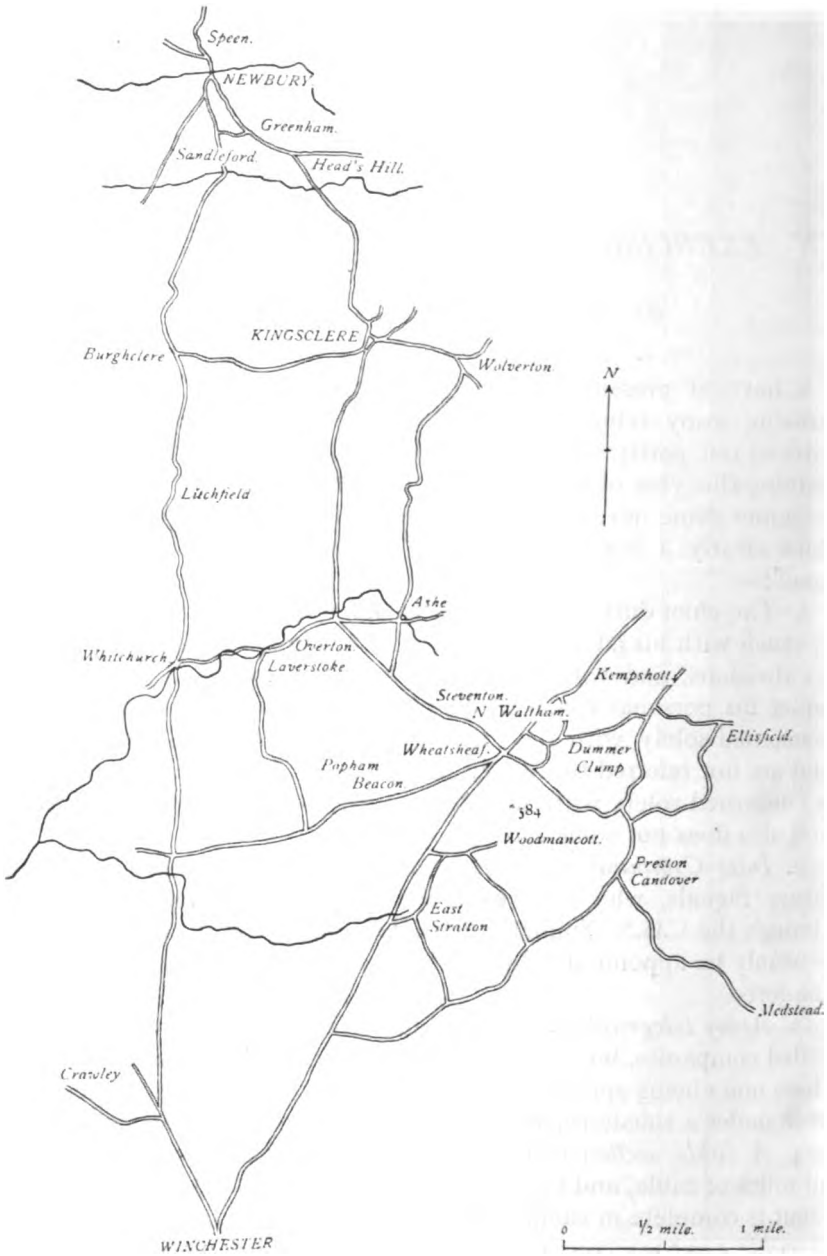

SCHEME.

A Red army, based on Liverpool, is holding the line, Bristol-Reading-Cambridge. The Blue forces hold London and the south-east of England.

Oxford is an advanced depôt, where spare telegraph troops have been concentrated. The 1st Air-Line and 1st Cable Companies are there.

NOTE.—All G.P.O. telegraphs are supposed to be non-existent.

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At 8 p.m., on July 1st, Major P., commanding 1st Air-Line Company, receives the following telegram (in cypher) from Director of Army Signals :—

"You are appointed A.D.A.S. of a force of three divisions, under General Z., which concentrates at Newbury and advances against Blue forces at Winchester on 4th July. Your own company (less one section) and the 1st Cable Company are at your disposal. A.D.A.S., Lines of Communication, will make the necessary arrangements in rear of the advanced depôt at Newbury. Assistant Director of Transport at Oxford has been warned that you will require extra transport for air line, which can be drawn from telegraph depôt at Oxford."

Major P. at once warns Major T., commanding the 1st Cable Company, to be ready to start for Newbury at 5 a.m. on the 2nd. He details his third section to remain at Oxford, as ordered, and leaves one captain in charge. He has available Capt. Q. and two sections; No. 1 under Lieut. R., and No. 2 under Lieut. S. Major T. has Capt. U. and four sections; C under Lieut. V., D under Lieut. W., A under Lieut. X., and B under Lieut. Y., with a ninth detachment.

From Newbury to Winchester is about 25 miles. The two air-line sections carry 20 miles air line. Major P. therefore considers about 20 miles spare will be necessary, and indents on A.D.T. for two wagons and teams to join his camp that night. These are at once loaded up with 20 miles air line (1 air-line unit, weight 8,700 lbs.) and two first-class offices (duplex, weight 1,300 lbs. each)—total weight, 11,300 lbs.

The column leaves at 5 a.m. on 2nd and marches 26 miles to Speen, on the outskirts of Newbury, where it bivouacs. It is a long march, but as there is no work to do, the spare men (who have to walk normally) can be given a lift for half the distance.

Major P. leaves Major T. in charge of the column, and rides on to Newbury himself, taking Capt. Q., who will be in charge of the base office and maintenance of the proposed air line. They arrive at Newbury by 10.30, and while Capt. Q. sees to a bivouac ground and supplies, Major P. reports to the C.G.S. of the assembling column, and ascertains, as far as possible, what is to be the plan of operations.

He is told that information has been received of the collection of Blue forces at Winchester, and that orders have been received for the column to operate against them—driving them back if possible and occupying Winchester. The troops are arriving by road and rail to-day and to-morrow, and are bivouacking :—1st Division at Head's Hill, 2nd Division at Sandleford Priory, 3rd Division (reserve) and headquarters at Greenham Lodge. The advance is to be made at 5 a.m. on the 4th—1st Division to Steventon *viâ* Overton, 2nd Division to Laverstoke *viâ* Litchfield, 3rd Division and headquarters to follow the 1st Division as far as Overton.

Major P. has therefore the whole of the 3rd July available to make his arrangements. He details his detachments as follows :—

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Capt. Q. in charge of base office at Newbury and the maintenance of the line. Lieut. R. (senior to Lieut. S.) in charge of air-line construction (four detachments available).

Major T. to control the cable work each day from the base cable office. Capt. U. to assist generally. Lieuts. V. and W., with four detachments, to keep 1st Division in touch; Lieuts. X. and Y. with 2nd Division. The ninth detachment is made up into a section (lettered E) by the addition of a cable wagon from No. 2 Air-Line Section, the detachment being found from the spare men of the cable company (commanded by the C.S.M.), and told off to keep headquarters in touch.

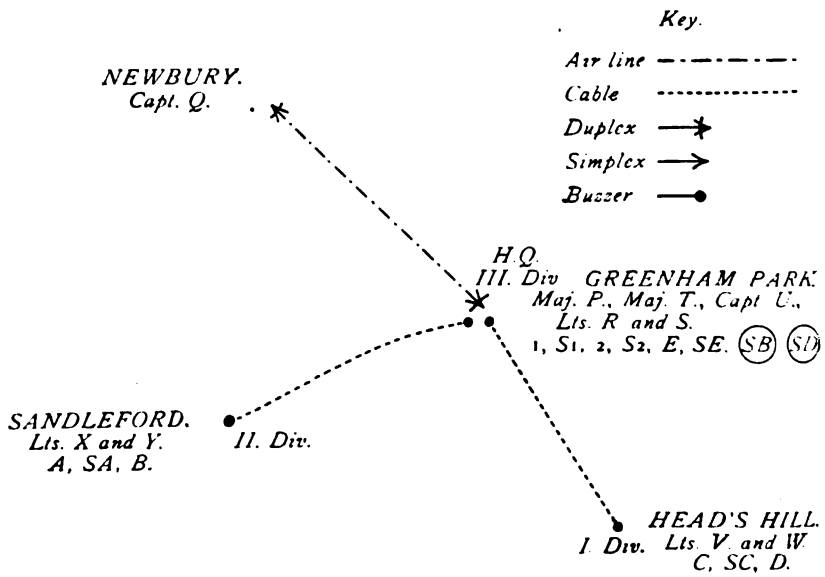
Spare men and wagons from both companies (including the two A.S.C. wagons) are made into a column under C.S.M., Air-Line Company. C.Q.M.S., Air-Line Company, is told off to assist Capt. Q. as inspector; C.Q.M.S., Cable Company, to look after supplies for telegraph details at headquarters.

Capt. U. sets up one of the first-class offices near the Lines of Communication telegraph office at Newbury, taking operators from No. 1 Air-Line Section. Lieut. R. runs air line from Newbury to Greenham Park (2 miles), and opens the other duplex office there. Telegraph headquarters move to Greenham Park.

Lieut. V. marches his command to the 1st Division at Head's Hill, running a cable line from Greenham Park, and leaving a cable detachment at Greenham Park to pick up (emptied of line stores into the other three detachments).

Lieut. X. acts similarly with the 2nd Division at Sandleford.

SITUATION ON NIGHT OF 3RD.



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NOTE.—The second detachment of each section is distinguished in the following pages by the letter S before the number or letter of the detachment. In the diagrams a circle round the letter denotes that the detachment has been emptied of line stores.

4th July.—*1st Division* starts at 6 a.m. and marches to Steventon Park *viâ* Kingsclere and Overton (12 miles). It arrives at 10.30. Lieut. V. leaves one detachment (D) at Head's Hill for the following purposes :—

(*a*). To keep an office open till the camp is cleared.
(*b*). To supply linemen during the day's advance.
(*c*). Eventually to reel up the line from Head's Hill to Steventon.

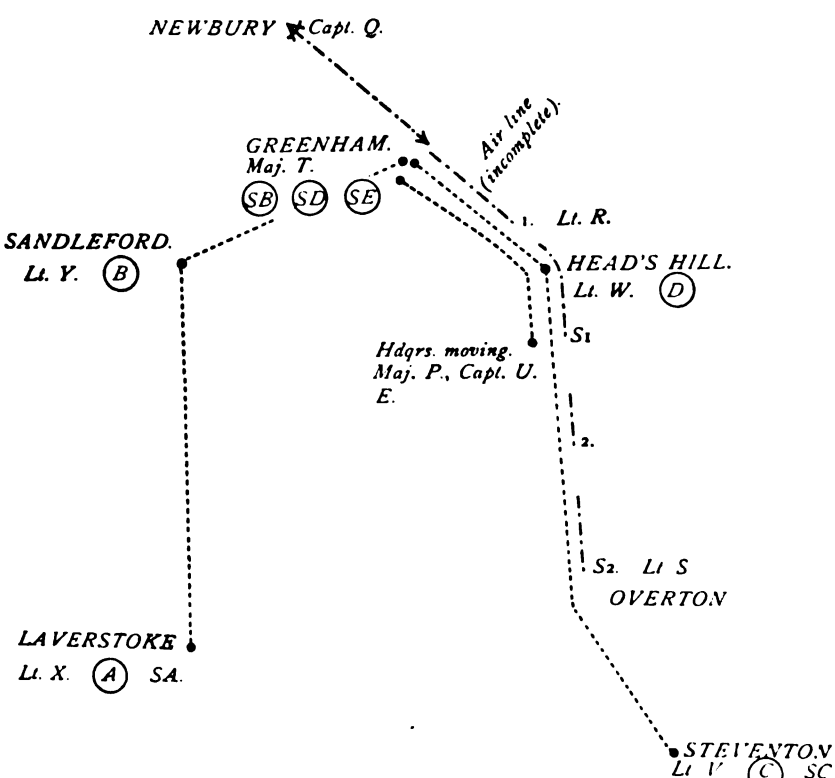
Lieut. W. is left at Head's Hill to look after maintenance.

Lieut. V. accompanies G.O.C., 1st Division, running out line from C Detachment, working into a base at Greenham Park under Major T. Base office and lineman are found from SD Detachment.

On arrival at Steventon, Lieut. V. reports by wire to A.D.A.S., and holds SC Detachment in readiness to run a cross line to headquarters when ordered.

2nd Division starts at 6 a.m. and arrives at Laverstoke at 10.30.

SITUATION AT 11 A.M., 4TH JULY.



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Lieut. X. makes similar arrangements, Lieut. Y. and B Detachment are left at Sandleford, A Detachment runs the cable, SA is in readiness to run the cross line.

3rd Division starts at 10 a.m. and marches to Overton.

Headquarters accompany the head of the 3rd Division. E Detachment runs cable with them, SE remaining to pick up. Major P. accompanies headquarters.

Meantime Lieut. R. has divided the road from Greenham Park to Overton into four lengths, and has put his air-line detachments on it at intervals. The work will be slow, as the road is blocked with troops, and it will be necessary to run the air line over the fields on each side. The distance is 10 miles, or $2\frac{1}{2}$ miles per detachment. The work will take about 5 hours and the march $2\frac{1}{2}$ more—the line should be through at about 2 o'clock, or at about the time headquarters arrives.

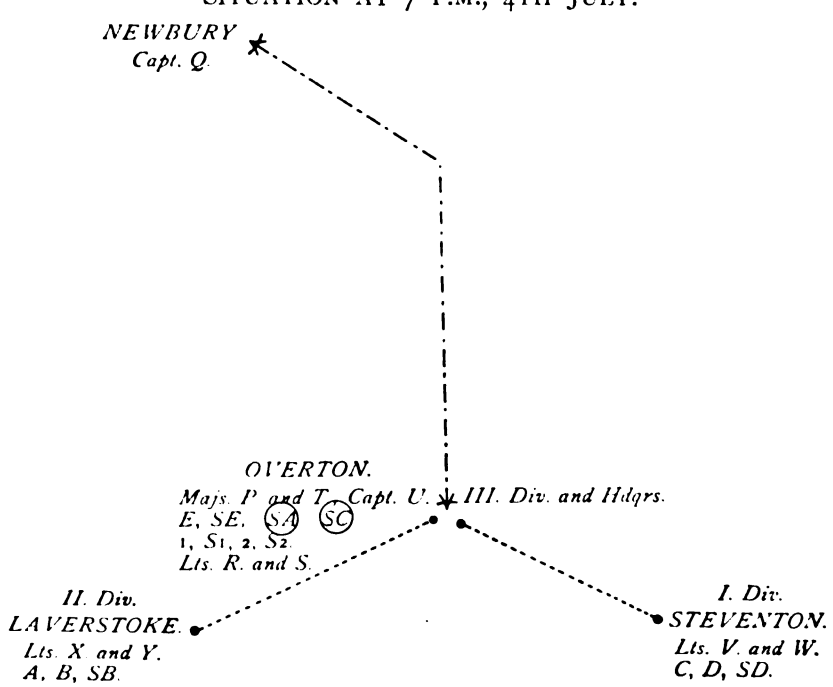
A first-class office is opened at Overton, Capt. U. being in charge.

On arrival of headquarters at Overton, Major P. sends telegrams to Lieuts. V. and X. telling them where the position of the camp is. They at once run cross lines in with SC and SA Detachments.

As soon as the air line is through to Overton, Major P. gives orders to Major T. that the cables may be picked up. The start under the above conditions would probably be made about 3 p.m., and the cable would be all picked up by 7 p.m.

The diagram would then be as follows :—

SITUATION AT 7 P.M., 4TH JULY.



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From which it will be seen that the detachments are arranged in exactly a similar manner to that of the night before, and are ready to repeat the operation for another day's advance.

NOTES.—(*a*). If, as frequently might be the case, the commander were to wait at Greenham till the afternoon, and then to go on at once to Overton in a motor car, the centre cable line would not be required, as communication with the 3rd (Reserve) Division would probably be unnecessary. E. and S.E. would then be spare.

(*b*). In the particular scheme taken the two divisions are very close to Greenham on the night of the 3rd—they might well be further off. The fact that the 1st and 3rd Divisions use the same road also somewhat complicates the standard diagram.

(*c*). It might well happen, especially in the case of an opposed advance, that the times would all be much later, and that consequently the cable lines would have to be picked up in the dark. This has been proved practically to be quite feasible. If the cross lines are run in the dark, Lieuts. V. and X. should accompany the detachments personally, and then return to their divisions.

(*d*). One of the subalterns on air line (Lieut. R.) should work with the rear detachment. If this detachment completes its portion and catches up another, he should remain with the one in rear. His duty is to test the line to the rear at intervals to ensure its being in good order, and he should not leave it until it is working well. He should keep a cable wagon with him in case the construction is overtaken by darkness and it becomes necessary to complete with cable.

5th July.—On the evening of the 4th the enemy is located on the line Medstead-Crawley, and the commander issues orders for an advance and attack.

The 1st Division is to attack *viâ* Preston Candover, 2nd Division *viâ* East Stratton, 3rd Division to be in reserve at Wheatsheaf (S.E. of N. Waltham). A.D.A.S. is also warned that communication will be required to two balloons, a mounted brigade on the left flank, and the heavy artillery, which has been withdrawn from the divisions and combined. The commander proposes to go to the high ground at point 584 (S. of Wheatsheaf), where he can get a view, but headquarters will be at Wheatsheaf.

Major P. must therefore be prepared for rapid communication from some 6 or 7 points to headquarters at Wheatsheaf. He must keep up communication to Newbury, and be ready for either an advance or a retirement after the engagement.

The three divisions start at 5 a.m. Headquarters will move from Overton to Wheatsheaf at 7 a.m.

Major P. makes the following arrangements :—

Lieut. V. to follow the 1st Division with C Detachment, sending in Lieut. W. with D and SD to report at Wheatsheaf at 6 a.m. Lieut. X. to follow the 2nd Division with A Detachment, Lieut. Y. to report at Wheatsheaf with B and SB at 6 a.m.

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Major T. to take E and SE to Wheatsheaf by 6 a.m., and to take charge of all six detachments.

Capt. U. to remain in charge at Overton.

Lieut. R. to run air line to Wheatsheaf as soon as road is clear of the 3rd Division.

By 6 a.m. D and SD are the only detachments that have arrived, the others all being blocked by troops moving, and not arriving till E and SE at 6.30, B and SB at 7. Major T. has slipped through himself, having got further information before starting that—

Mounted brigade is to be at Ellisfield.
Heavy artillery at Dummer Clump.
A balloon at Kempshott.
A balloon at Popham Beacons.

He chooses a suitable field at Wheatsheaf for the Headquarter Office, and gets out a diagram of the connections required to which he can work.

Lieut. V.'s line (with the 1st Division) is cut at Wheatsheaf, and a spare office put on either end.

D and SD are sent out at once to point 584 and balloons at Popham Beacons, as these roads are clear.

On arrival E and SE are told off to balloon at Kempshott and mounted brigade at Ellisfield.

On arrival B is sent to HA at Dummer, SB remaining spare.

All the detachments work outwards from Wheatsheaf. The times are approximately as follows :—

D.—Arrive 6 a.m.	Leave 6.30.	Through to 584 6.45.
SD.—Arrive 6 a.m.	Leave 6.30.	Through to balloon 7.0.
E.—Arrive 6.30.	Leave 6.45.	Through to balloon 7.15.
SE.—Arrive 6.30.	Leave 6.45.	Through to mounted brigade 8.0.
B.—Arrive 7.0.	Leave 7.15.	Through to HA 7.45.

The enemy is in force, and the Red force can barely do more than hold its ground. This situation, only reported by wire to the distant C.-in-C. of Red forces, produces from him an order to fall back gradually to the strong position on the high ground S. of Kingsclere. This order is received at 6 p.m.

The commander issues orders at 6.30 p.m. for the 3rd Division to act as rear guard, holding the line Woodmancott-Dummer to-night, with divisional headquarters at Wheatsheaf. The 1st and 2nd Divisions to retire to-night to their old camps at Steventon and Laverstoke. Further retirement to be made on 6th—1st Division *viâ* Ashe to Wolverton, 2nd Division *viâ* Litchfield to Burghclere, 3rd Division (rear guard) *viâ* Overton to Kingsclere, new headquarters to be at Kingsclere. 1st and 2nd Divisions to start at 5 a.m., 3rd Division to be clear of Overton by 7 a.m., headquarters move at 5 a.m. by motor.

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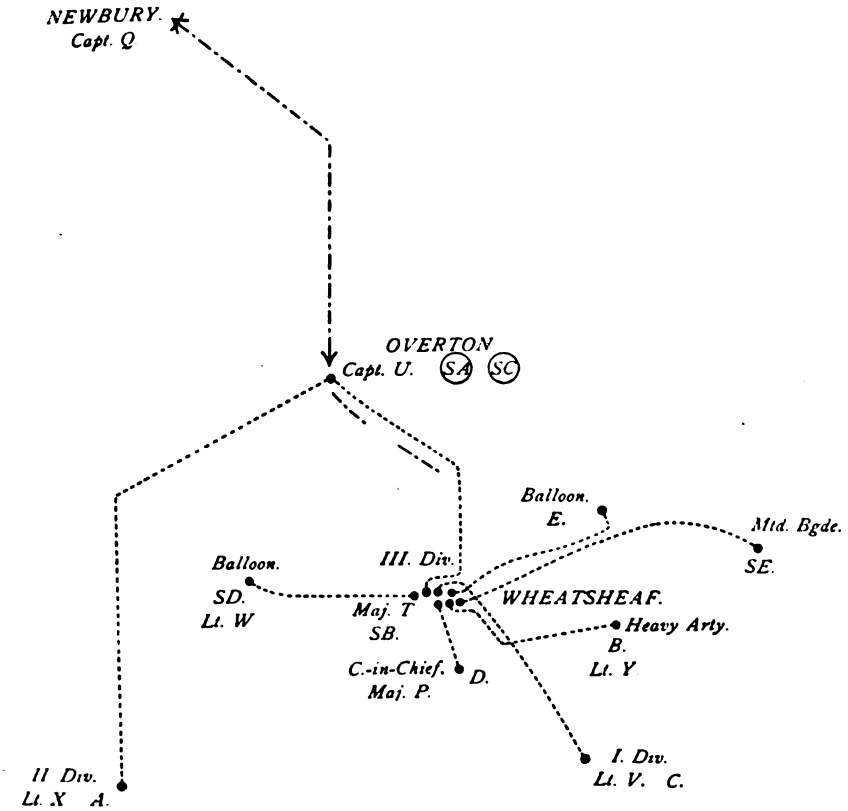
At 8 a.m. the diagram is as follows :—

SITUATION AT 8 A.M., 5TH.



Major P.'s problem to-night is to get his detachments back to their places ready for an early retirement to-morrow. A and C will naturally reel up with their divisions; but C must now stop at Wheatsheaf for the 3rd Division.

The remainder of those working out from Wheatsheaf reel up to that place as soon as they can be spared, and are then distributed as follows :—

With 1st Division at Steventon—D, SD, and SE.
With 2nd Division at Laverstoke—A, B, and SB.
With 3rd Division at Wheatsheaf—C.

At Overton SA, SC, and E. E takes in enough spare line stores from the other detachments to fill up SC.

The air line from Overton to Wheatsheaf is either abandoned or picked up as far as possible.

NOTES.—(*a*). A clear head and rapid decision on the part of Major T. and good drill and quick appreciation on the part of the

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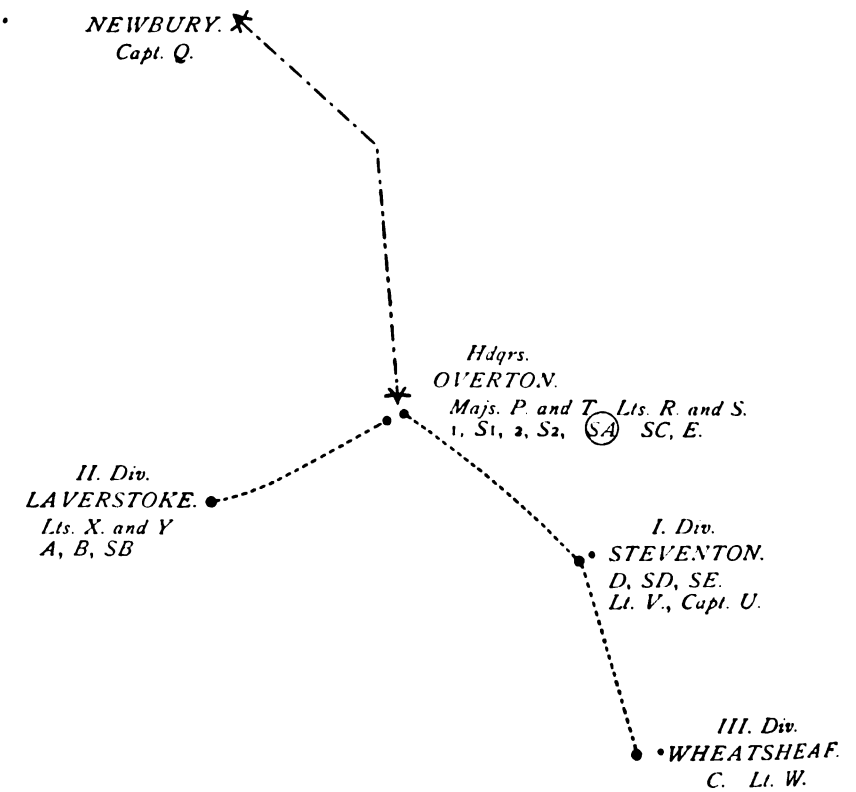
detachment commanders are required to get the central office at Wheatsheaf working without undue delay. Each detachment must be provided with a diagram of the circuits for the day before it leaves.

(*b*). The arrangement by which the Headquarter Staff remain at the base cable office and the commander goes on where he can see, is one which is frequently adopted and which has everything to recommend it from a telegraph point of view. Special attention must be paid to the cable to commander, or a block will occur; if however the staff remains at the base office, the work on this line is not likely to be unduly heavy.

SITUATION ON EVENING OF 5TH.



6th July.—The detachments are early astir, leaving camp as soon as it is light enough to see anything (about 3 a.m.).

B and SB, under Lieut. Y., run fast cable *viâ* Litchfield and Burghclere (where an office is dropped) to Kingsclere. Distance, about 13 miles; time, 2 hours. The roads are clear.

D and SD, under Lieut. V., run fast cable *viâ* Ashe and Wolverton (where an office is dropped) to Kingsclere. Distance, 10 miles; time, under 2 hours.

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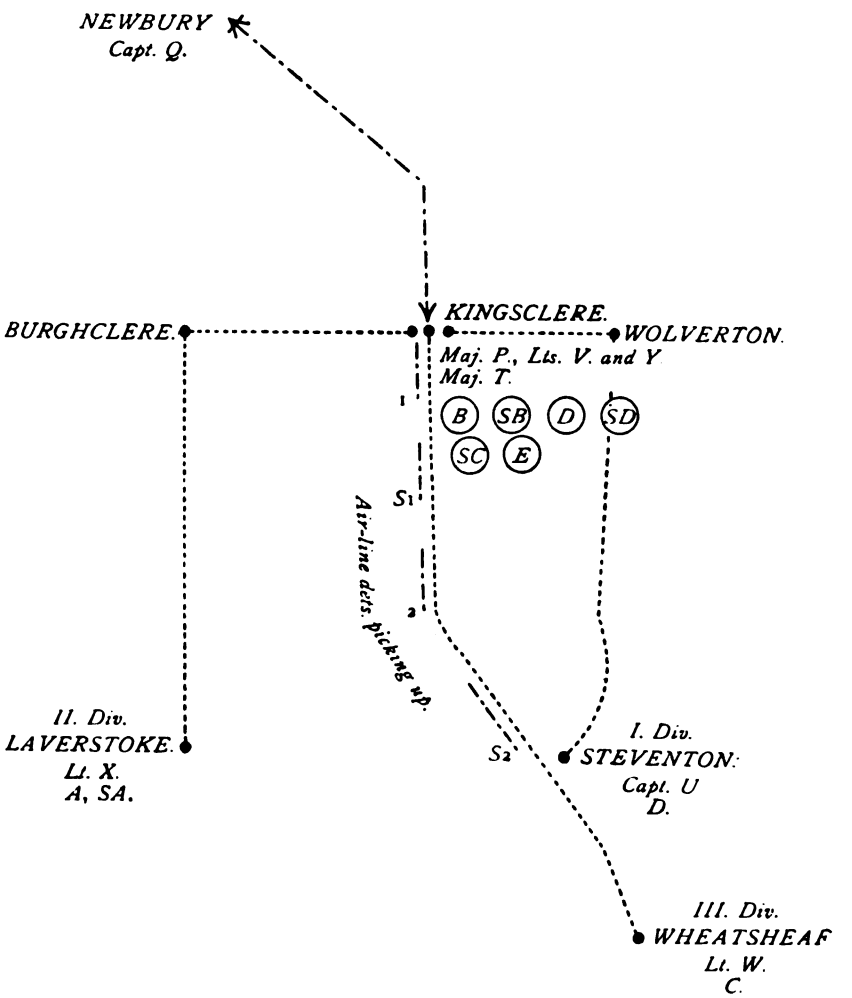
SC and E, under Major T., run fast cable to Kingsclere. Distance, 5½ miles; time, 1 hour.

Lieuts. R. and S. get the air line picked up, starting as soon as headquarters leaves Overton, and abandoning any that cannot be removed before the road is blocked by the 3rd Division.

Capt. U. with D., Lieut. X. with A., Lieut. W. with C., pick up the lines with the 1st, 2nd, and 3rd Divisions respectively as they retire.

Major P. gets back early to Kingsclere, and arranges the office there.

SA picks up the line Overton to Laverstoke, and comes in with A.



NOTES.—(*a*). On a clear road, two good detachments, working fast cable drill, can be relied upon up to 12 miles in 2 hours—

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possibly even a little quicker. For a greater distance than this the pace would begin to tell on the horses.

(*b*). In this scheme the running-out detachments got 2 hours daylight before the divisions moved. If the start had been earlier, the cable could have been run more slowly by night. If there is no time available, the communication must lapse till the lines to the rear have been run out.

General Remarks.—In the above scheme an attempt has been made to provide for three typical cases—an advance, an engagement, and a retreat; but of course the variations are infinite.

Practical trials show the great necessity of care on the following points:—

(*a*). Every telegraph office must be provided with a clear diagram of the circuits existing. These should be copied by hand before starting whenever possible; any changes must be telegraphed.

(*b*). The call signals of offices require careful consideration in order to avoid confusion. The method which appeared to give the best results was that each moving wagon should have as call its own letter prefixed by P, thus PA, PSC. When an office was definitely established at a given point, a two-letter call, derived from the name of the place, was at once adopted, and reported to A.D.A.S. (thus GP for Greenham Park).

(*c*). When a cable detachment runs out a line, leaving another to pick up, the base operator, office, and lineman should be found from the detachment detailed to pick up, that running out going on complete. Otherwise it is frequently almost impossible to get the base office back to its own detachment.

(*d*). The senior officer or N.C.O. in charge of a detachment should be personally responsible for the traffic. He should have subordinates ready detailed to arrange for (1) care of horses, (2) cooking for men, (3) provision of supplies for next day; so that he has not to give more than a general supervision to these important matters.

(*e*). The mixing up of units referred to in "axiom" 3, becomes very manifest. Officers employed on intercommunication service must be interchangeable, and each system must be directed by the senior officer, irrespective of what unit he belongs to.

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THE EMPLOYMENT OF SAPPERS ON THE WORKS—SOME SUGGESTIONS.

By Lieut.-Colonel W. Baker Brown, R.E.

In the very interesting article on the above subject in the April number of the *R.E. Journal*, "A Company Officer" describes clearly and forcibly the point of view of those who think with him that the military training of the Sapper, especially in field companies, should swamp his engineering duties.

On this thesis he builds up a carefully arranged superstructure for their employment on works, principally with the idea of effecting thereby a financial saving. But there is another side to this question if it is considered from the only essential point of view—the work to be done by an Engineer company in war.

The general commanding an army in the field will look to his Chief Engineer not only for field entrenchments, obstacles, and military bridges, but also for much work, which would come under the definition of "works," as carried out by the R.E. in peace. Such "works" might include, at the base of operations, the construction of piers, the improvement of approaches, the alteration or even the erection of such buildings as hospitals, barracks, or stores. On the line of communications there are again roads to make and mend, bridges to erect or repair, while semi-permanent camps and hospitals will require drainage and water, and hutting may have to be erected.

On the line of march the duties will be mainly of a military nature, but as soon as the army halts, "works" duties in connection with water, drainage, and roads will again fall on the Engineers.

In any campaign the period of preparation and concentration is necessarily long, as compared with the time occupied in marching and fighting. It is therefore probable that the demands on the Engineers for "works" will be ten or a hundredfold greater than the demands for fieldworks.

If this view is correct, then the employment of Sappers on "works" in peace is a direct preparation and training for duties

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which they will have to do in war, and is quite as important from the military point of view as the less difficult if more interesting field training.

Even assuming a quite different proportion, there are many points in which a careful training on "works" in peace may form a most valuable training for the execution of purely military projects in war time.

In both cases there should be a well thought-out design, with due consideration given to local conditions and materials available. In both cases there should be economy of time, tools, materials, and labour. In both cases there should be a careful organization, so that all men are employed to the best advantage, and that tools and materials are at hand, when wanted, without either starving the work by delay in the receipt of stores, or overcrowding the store depôts and perhaps congesting the line of communications by demanding stores in excess of requirements.

But while many officers admit this to some extent, they will not extend their admission to consider "incidental" services about barracks as anything but harmful. And yet, I suggest, that these very incidental services might be made a most valuable training for the junior ranks, in placing responsibility on individuals and exercising forethought in small details.

Let each barracks or group of barracks be placed in charge of a small squad of mixed trades—a couple of carpenters, a plumber, a glazier, a painter, a labourer or two—one to be a junior N.C.O. Give them a suitable equipment of tools, a building as a shop, and authority to obtain stores in small quantities. Then let the N.C.O. understand that he will be judged by the efficient repair of the barracks, and that all minor repairs can be carried out by him as soon as discovered, all action being reported to the foreman of works.

The quartermaster, or other O.C., might be allowed to report urgent requirements direct to this N.C.O., but much requisitioning and correspondence might be saved by a systematic inspection of water taps, sanitary appliances, fittings for lighting, sash lines, locks, ranges, etc. A stitch in time saves nine, and early repair is not only cheapest, but saves the tempers of the occupants and the waste of water, gas, or fuel. Small renewals and periodical services might be allotted to this squad.

But a field company officer may possibly say "This is all very well and is a very good description of the work of a fortress company at the base or on the line of communications, but a field company must be kept for more purely military duties." As an example, I have known an officer grumble because his field company was employed—

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after the advance on Pretoria—on concrete work in connection with a general hospital.

How far it is desirable to rest the Engineer units for a few days prior to an advance is a matter for the Chief Engineer in any particular case, but it seems the obvious duty of all Engineers to be ready and willing to undertake any engineering operation, and for this a careful peace training on "works" is essential.

Another curious point in the article I refer to is the line drawn by "A Company Officer" between men working in squads under the supervision of their officers, and those employed as clerks, storemen, or engine drivers or "absorbed in the R.E. workshops." All these latter are referred to as if they were wasted, and the employment of men on "Station" duties as very undesirable. Similarly he thinks printers and suchlike should be on the Supernumerary Staff and not in the unit.

With this view I entirely differ. Any engineering operation requires an efficient organization of the clerical and store duties, just as much as of the working parties. To say that the office organization is the duty of the C.R.E. or D.O., and that the unit only carries out the work, is to overlook some of the primary conditions of work in war. In war time there will be no organization of a D.O.'s office ready made into which the work of a field company can be fitted, but the company will have to develop an organization for the purpose from its own *personnel*. Of course, in war time some of the financial checks, necessitated in peace by our political system, will be dropped, but there will still remain the necessity for a careful store record, and an irreducible minimum of clerical work, which requires trained handling if the officer is to get the best result out of his men.

Again, the Supernumerary Staff (to use the old term) is in essentials a staff of senior N.C.O.'s with certain special qualifications. The individuals are not posted to units, mainly because their military rank would give them undue seniority. They correspond in that sense to the regimental staff of a battalion. But they are just as much part of the engineering organization as any junior N.C.O. of the units.

In a few special instances, such as wireless telegraph and electric light units, mechanists are included in the war establishment, while clerks and storekeepers are also included in other cases. But foremen of works are not recognized in the field. Would there not be many advantages in attaching a military foreman of works to every field company, in the same way as they are generally employed in fortresses in superintending military works on mobilization?

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Although the Supernumerary Staff is treated for certain military purposes as detachments of one large unit, there is a distinct gain in attaching them to the local unit, when one exists, for such purposes as pay, quarters, and clothing; not only does this save the necessity of keeping a separate system of accounts for a small group of N.C.O.'s, but it brings the Supernumerary Staff into much closer touch with the military side of the engineer organization. Similarly all men, such as the junior clerks, storemen, printers, etc., who can be so dealt with, might be posted to the unit. This might make a little trouble for the O.C. Company in arranging duties and exemptions, but would surely be much better for the men concerned, and it emphasizes the military character of the whole organization. And this leads at once to a consideration of the other side of the question, viz., the military training, which in the opinion of "A Company Officer" necessitates the attendance of every individual man of the company for a solid six months of the year.

If we look at the syllabus of the courses which now constitute the annual programme of military training, we shall at once see that in the case of the engineer companies we can subdivide the training into two distinct parts, the training as a soldier, the training as an engineer.

The former may be further divided into three heads, (1) the use of the rifle, (2) sufficient drill to enable the company to move to any desired point without hurry or confusion, and (3) a knowledge of the military organization and military requirements of other arms.

The engineer training may be divided into two essentials:—(1) A knowledge of the special equipment carried in the field by each unit and the best methods of using it, and (2) the execution of larger works, such as a heavy bridge, blockhouse, or entrenchment.

It is also evident that the annual training involves the teaching of little that is new, but is mainly a repetition of work already learnt in detail as a recruit.

Taking first the military side, in the opinion of many, the best way to practise drill is to devote to it one or two hours a week throughout the year. The same principle holds with the use of the rifle, only that the want of ranges and a somewhat short allowance of ammunition necessitates the concentration of the actual work on the ranges into a "course" of about a week's duration. There remains then to be acquired a familiarity with other arms, which can only be partially acquired in barracks, and requires the close companionship of work in the field to become really effective.

On the engineering side, familiarity with equipment is best obtained

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by combining the use of tools with the weekly drill, provided some ground for practice can be obtained in the neighbourhood of barracks. And if suitable works organization has been established and practised, the execution of a larger engineering project, such as a blockhouse, redoubt, or heavy bridge, becomes mainly a question of getting the materials on the spot, the execution proceeding on the same lines as a job in peace.

There remains the use of technical equipment to consider. Omitting the special case of such units as balloon, telegraph, or electric light companies, where the technical training required is considerable, the special technical training for field and fortress companies is practically limited to two things—the use of explosives and bridging over water; these must be provided for. The last is especially important for companies not stationed near the sea or a large river, as the handling of boats cannot be learnt in a pond or canal.

But it will no doubt be urged, and justly, that the above summary deals mainly with the training of the sapper, and that the training of the officers and N.C.O.'s demands the assembly of the company as a whole in order to practise the handling of a large body of men in the field. This will surely be best obtained by a regulated system of training, under which the training of the individual will merge into that of the section, and the section into the company. But of the possible grouping, I am inclined to lay most stress on the training of the section under its subaltern.

This is for Engineers the real fighting unit, and corresponds to the company of an infantry battalion. It is only on special occasions that a major of a field company will find himself personally directing the work of his whole company; more frequently he will be left with his headquarters only, while his sections are carrying out the work, and looking to company headquarters to supply them with tools, stores, and food. Further, his peace unit is only a skeleton of what he will command on mobilization, and the lessons learnt by handling a skeleton only are apt to be misread.

Taking all the above into consideration, I suggest that the military training of an engineer company might consist of the following:—

(1). An *individual* training throughout the year, including weekly drill, musketry exercises, and such elementary engineering as gabions, fascines, shelter trenches or spar bridging. Lectures to be given periodically and bad weather utilized for simple exercises in working out details of work in the field.

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(2). *Section* courses of musketry (1 week) and military engineering (2 to 3 weeks), the latter to include the selection of a camp site and the collection of the necessary material, with as much water work as possible.

(3). A *company* course of a week or 10 days, to be conducted as a practical examination of the sections and individuals by the commanding officer. This would be followed by the annual combined manœuvres with other arms.

Once every two or three years an extra course of pontooning or siege work might also be possibly arranged.

In addition, general officers might call on the Engineers for assistance with the training of other arms, and might also require actual work to be carried out in preparing camps, etc. This latter would be treated as a "works" service.

But the point I want to make is that none of the above is inconsistent with the supervision of "works." Except for the company course or for manœuvres, it should always be possible to keep half the company in barracks, and even during manœuvres men required for special work, as for instance engine drivers or printers, could remain in barracks every second year with no detriment to the training.

The organization which I would suggest to carry out the above, is as follows for a field company on the home establishment. The principle will apply equally to fortress companies, but as these have a varying establishment, the details will differ.

The officers of a field company in peace should be 1 major, 1 captain, and 2 subalterns. The major would command the whole company, and would be the division officer of the whole area in which the company is employed. This is a most important point, as it then rests entirely with him to adjust the varying claims of "works" and military duty.

The captain would help the major with the division work and act for him while absent, but his special duty should be the military details of the company, pay, clothing, food, and barracks. He should be in charge of the horses, vehicles, and field equipment.

The men of the company would be divided into a headquarters and two sections, each section having attached to it a cadre of another section, which would be filled out on mobilization.

Each section should be under a subaltern, who would have charge of a subdivision for "works."

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If central workshops exist for a division, they could be in charge of one of the sections or be placed under the captain, but such details and many others would depend on the local arrangements of barracks and areas.

I suggest that on the above lines a combined works and military organization could be developed which would produce the fine combination of soldier and sapper which we look for in our military engineers.

In conclusion, two points of detail which may cause difficulty may be briefly referred to.

The first is the paucity of men in a home unit. This is an admitted evil which can unfortunately only be remedied at present by reducing the number of cadres. Such a reduction however is practically impossible, as the ever-increasing application of science to modern warfare leads to the formation of new cadres of military engineers instead.

But from the works point of view it can be met by supplementing the military labour by the engagement of pensioners, the utilization of infantry, or in other ways which were suggested by a company officer. Pensioners from R.E. might be always employed with advantage in the central workshops, and when employed would form a convenient nucleus quite capable of carrying on any urgent work during the absence of the company at training.

The second difficulty is the existence of the triennial contractor. The system of ordering work on a schedule and paying for it by an arbitrary scale, which includes materials, labour, supervision, and a host of minor expenses in one payment, is quite unadapted for war.

Its use thus necessitates special knowledge from officers and men, which has little military value.

In war time the Engineer officer has himself to do the work of collecting material and men, and has to arrange for its supervision, all of which is done for him in peace by the contractor.

On the other hand, an order on the triennial contractor is for many officers and foremen of works a happy solution of an engineering problem, as no foresight is required and it involves the minimum of work until the job has to be measured. As long as a triennial contractor exists, the temptation to employ him will always be present. Even if stores only are ordered on the triennial contractor, the officer is still avoiding the useful exercise of finding the best source of supply.

The remedy is, I suggest, to abolish the triennial contractor and to substitute local contracts for the supply of building materials, etc. Even if no military labour be available, a system of direct employment

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of day labour should be feasible, and will give excellent training to officers and foremen.*

It must however be noted that the direct supervision of work requires more staff both in the office and on the works, a larger stock of stores is required with suitable store buildings and *personnel* to handle them, and a good central workshop is a necessity for economical working. The present system under which all permanently employed staff is paid on a separate subhead of the Vote, instead of being charged against the various items, rather prevents elasticity and undoubtedly militates against the general adoption of a direct system.

* It is understood that in the revision of the "Regulations for Engineer Services," which is now in hand, it is proposed to say that the execution of services by civil day labour directly employed by the War Department may be authorized by the Chief Engineer either simultaneously with or in substitution for the execution of such services under contract, provided that he is satisfied that efficiency and economy is thereby insured.—ED., *R.E.J.*

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THE FYERS FAMILY.

(*Continued*).

By Col. Robt. H. Vetch, c.b., late R.E.

Lieut.-General William Fyers, Colonel Commandant, R.E.

(*Continued*).

Fyers was promoted to be Capt.-Lieutenant on the 20th April, 1787, and in October, 1788, he was sent from Gosport to Gibraltar. On his arrival there, he was posted to the command of a company of Royal Military Artificers. At this time he was a subaltern of 15 years service, half of them war service. It was not until 1793 that he was promoted to be Captain, and a brevet majority followed two years later. In 1795 he succeeded Major-General Robert Morse* in command of the Royal Engineers at the station. He became a Lieut.-Colonel in 1800 and a regimental Colonel in 1806. All this time, some 18 years, he spent at Gibraltar, and the story of his life is a history of the Rock and its defences. Even were the material to hand, it would be tedious to enumerate the details of this service, because, although Gibraltar was a centre in close touch with the naval and military operations taking place in the Mediterranean, it was itself unattacked. Some extracts from the reminiscences of his daughter bearing on her stay at Gibraltar may however be of more general interest. The MS. seems to have been compiled after her marriage, probably long after.

"I must have been in my third year when we landed at Gibraltar. The only distinct recollection I have is being in a large room in a house near the King's Bastion, which was crowded with packing cases. Some of them had been opened and there was a sad litter of straw about. . .

"My brother Edward and my sisters Anne, Arabella, Louisa, and Fanny were born at Gibraltar. Arabella, who died young, was named after Lady Boyd, the wife of Sir Robert Boyd,† the Governor, who was

* General Robert Morse, afterwards Inspector-General of Fortifications, and Colonel Commandant, R.E., was C.R.E. at Gibraltar from 1791 to 1795. He was promoted to be Major-General while serving there in 1793. See *Dictionary of National Biography*.

† General Sir Robert Boyd was second in command at Gibraltar under Lord Heathfield during the famous defence of 1779—1783, and in 1790 succeeded him as Governor. He died at Gibraltar and was buried in the King's Bastion in 1794. See *ib.*

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her godfather. Edward was named after Prince Edward,° who was there with his regiment. The Prince was a frequent visitor at our house, and did the family the honour to stand godfather to the boy. I well recollect the bustle caused by the preparation of a splendid entertainment on the occasion of the christening in honour of the illustrious guest. My eldest brother Thomas, then about 8 years old, was a constant attendant at parades, and was much noticed by the Prince. When His Royal Highness came to the entertainment my mother was amused by his telling her he knew every dish she was to have for supper, and then he proceeded to go through the bill of fare. It came out that Thomas, after the parade that day, had been unable to keep to himself all the good things that had been provided, and disclosed them to his august friend. . . .

"How many names of well-known persons who were friends of my father at Gibraltar crowd in my memory:—Drinkwater,† who wrote the history of the siege and who assisted my father to lay the foundation of the magnificent garrison library at the Rock; General O'Hara,‡ and his dear, good aide-de-camp, Capt. Douglas, who used to tell us so many funny and amusing stories; Graham,§ Hutchinson||, Doyles,¶ Philpot, Whitmore, the Marquess of Huntley,°° Wemys,†† Lemprière,‡‡ and many others. We had also an extensive naval acquaintance. Among them was Capt. Elphinstone (Lord Keith), who always had a bed at our house when he chose to remain on shore, and it was with him that my father went for a tour in Spain. . . .

"The time was now approaching (1793) when my brother Thomas was to be sent to England for his education, for there were no English

° Prince Edward Augustus, Duke of Kent, grandfather of the present King, was born in November, 1767, and was therefore at the time (1791), when he was serving at Gibraltar, 24 years of age.

† Colonel John Drinkwater, afterwards Bethune, was a young officer in the 72nd Foot (Royal Manchester Volunteers) during the siege he chronicled; he went home after the siege, and exchanging into the 1st Royals returned to Gibraltar. He went with his regiment to Toulon in 1793, where he was Military Secretary during its occupation. See *Dictionary of National Biography*.

‡ General Charles O'Hara served in the American War. He was a Major-General on the staff at Gibraltar from 1787 to 1790, and became Lieut.-Governor in 1792. He was promoted to be Lieut.-General in 1793, and later in that year was sent to Toulon to replace Lord Mulgrave in command of the British troops there. In repulsing the attack by the French on Fort Mulgrave, General O'Hara was wounded and made a prisoner. He was taken to Paris and confined in the Luxembourg until August, 1795, when he was exchanged with General Rochambeau. He returned to Gibraltar as Governor, and after much suffering from complications caused by his old wound he died there in 1802. The memoir of him in the *Dictionary of National Biography* says that he proved himself a very active and efficient Governor. "His old-fashioned discipline was rigid, but just and fair, while his lavish hospitality and agreeable companionship made him generally popular." He was nicknamed the "Old Cock of the Rock," and in his Kevenhüller hat, with a double row of sausage curls projecting on either side, and his legs encased in big jack-boots, he affected (although a young man for his

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masters in the garrison. He had been for some time under the care of the garrison chaplain, the Reverend John Hughes, but as he was intended for the Royal Engineers, it was necessary for him to go through a regular preparation for the examination on entrance to the Royal Military Academy. The mention of Mr. Hughes reminds me of a good turn that my brother did for his tutor. There were supposed to be two chaplains at Gibraltar, one for civilians and the families of officers, and the other for the garrison, to whom he read prayers every morning on the Grand Parade. He also visited the sick in hospital. Mr. Hughes was without an assistant, and was in fact doing double duty, and applied to the Governor for increased pay. This irritated the Governor, and at our house one morning he abused the poor man for what he termed his greediness. On this Thomas, who was present, looked up from his corner and said in a distinct voice 'The labourer is worthy of his hire.' General O'Hara was so much struck by the words and the serious manner of the child that he said: 'Well, my boy, Mr. Hughes shall have the additional allowance, and you have gained it for him.' Thomas° was sent home to his uncle, Mr. Thomas Fyers, then living in London, or staying with the constant friend of the Fyers family, General Whyte Melville. Endeavouring to find his uncle's residence, the boy wandered about until he was weary. At length a gentleman asked him if he had lost his way and what his name was; 'Thomas Fyers! Why that is my own name,' and he caught the little fellow in his arms. He was soon comfortably settled with his uncle, and later placed at a school at the

years in other particulars) the old-fashioned garb of Ligonier and Granby. See *Dictionary of National Biography*.

§ General Sir Thomas Graham, Lord Lynedoch, was aide-de-camp to Lord Mulgrave at Toulon in 1793, and was at Gibraltar with his regiment off and on from 1794 to 1798. See *ib.*

‖ General John Hely Hutchinson, Baron Hutchinson, afterwards second Earl of Donoughmore. See *ib.*

¶ There was quite a family party of Doyles at Gibraltar at the end of the 18th century; General Sir John Doyle was a brigadier there. He had served throughout the American War, and in 1793 had raised the 87th Foot, in which his nephew, afterwards Lieut.-General Sir Charles William Doyle, served, and in 1798–99 was doing duty as brigade-major at Gibraltar, while Colonel Sir John Milley Doyle was Sir John's aide-de-camp. See *ib.*

°° George, 9th Marquess of Huntley, a captain in the 3rd Guards, raised the 100th Foot (afterwards the 92nd Foot) in the beginning of 1794, and went with it to Gibraltar.

†† General David Douglas Wemys, served with the 49th Foot in the American War, was promoted Lieut.-Colonel with the 18th Royal Irish, which he took to Gibraltar in 1797. He was employed as a brigadier-general on the staff at Gibraltar until 1802. See *ib.*

‡‡ William Lemprière, the traveller and medical writer, was an army surgeon at Gibraltar in 1789, when his services were lent to the Emperor of Morocco. He returned to Gibraltar in 1790, where he was lionized on account of his travels in Morocco, of which he wrote an account. See *ib.*

° Thomas Fyers got his first commission in the Corps in May, 1800. His uncle and namesake was the Treasurer of Malta, already referred to.

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Blue Stile, Deptford, where they professed to prepare boys for the Royal Military Academy. . . .

"In 1793 the state of France was the chief subject of discussion at the Rock, and being with my mother sometimes when there were visitors, I was greatly interested in the conversation. I cannot express the horror I felt when I heard of the execution of the French King, and of all the subsequent cruelties and the barbarous murder of the Royal family of France. As many men-of-war were at this time constantly coming into the harbour to refit or obtain supplies, we knew something of importance must be going on. One day a neat compact chest was brought to our house, and we children were anxious to know its contents. It proved to be a canteen for my father. Then we heard that General O'Hara was going with troops on an expedition,* and that my father had asked to be allowed to go as a volunteer. The General however refused to listen to his entreaties, and told him that a soldier must go where he was ordered to go, but the father of a large family had no business to volunteer for a service of no little risk to which he had not been ordered. It was quite sufficient for him to remain at his post and be ready to act when called upon.

"We were very sorry when our kind friend, General O'Hara, left us, and we did not hear any news of him for some time. General Rainsford† was left in command of the garrison during his absence. General Rainsford was a most eccentric man and a firm believer in animal magnetism. He used often to send for my father and Capt. Dickens (afterwards Lieut.-General Sir Samuel Trevor Dickens, K.C.H., who died in 1847) to read long dissertations to them on the subject. . . . One day when they dined with him and were taking their places at table he called out to one of the company: 'Do not sit down in that chair, it belongs to Mrs. Rainsford. She comes in at the window over there and takes her meals with me every day.' Mrs. Rainsford had been dead many years. . . .

"When news arrived of General O'Hara, we heard he had lost an arm and been taken prisoner by the French, who treated him with great indignity. . . . French Royalist emigrants flocked to Gibraltar in considerable numbers for protection and safety. Many of them had not had time to secure a change of clothes, and were reduced to great necessity. Joseph, the German barber who attended my father every day, told him there was a family of rank—Capt. and Madame Cibon with one daughter—who were suffering much distress. They had first fled to Carthagena, accompanied by a faithful servant, Joseph, and his wife and child. At Carthagena the servant established an eating house, or cook-shop, and being a clever cook, succeeded in earning enough for the maintenance of all the party. But soon the Spaniards began to waver in their attachment to the French Royalists and to combine with the French and Dutch Republics against Great Britain. Then these unfortunates were

* He was going to Toulon.

† General Charles Rainsford was previously in the Coldstream Guards. He was a scientific man, a Fellow of the Royal Society and of the Society of Antiquaries, and dabbled in alchemy. See *Dictionary of National Biography*.

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obliged to seek another asylum; the move to Gibraltar exhausted their slender resources, and they were reduced to the greatest extremities. Joseph reminded Capt. Cibon that on quitting Marseilles a casket had been confided to him by a friend which no doubt contained money or jewels, and he thought the emergency of the case should hold him excused if he opened it and made use of its contents. 'No,' answered M. Cibon, 'nothing shall induce me to break a trust imposed upon me, however great my sufferings may be.' The hairdresser told my father that Madame Cibon proposed to take a limited number of pupils and endeavour to earn something towards their subsistence, and perhaps be able to assist their man-servant in starting a cookshop in Gibraltar.

"On hearing this my parents resolved to send my sister Charlotte and myself to her daily for a couple of hours to learn French. Meanwhile it became known that the British Government intended to grant pensions to all the Royalist emigrants according to their rank and the number of their family. On learning these benevolent intentions, the Cibons refused to receive remuneration for the instruction of their English pupils, though of course the number, which consisted of three (my sister Charlotte and myself, and Anne, the daughter of Mr. Hawkins, of the Ordnance Department), was not increased. This was the commencement of my friendship with the noble-minded Madame Cibon, the benefit of which I felt throughout my life. . . .

"An exchange of prisoners at length liberated our friend, General O'Hara. How rejoiced we all were to see him again, and to find that the report of his having lost an arm was untrue. He had, indeed, been wounded in the right arm, but it had got well. On the occasion of his first visit to us, the chief subject of his conversation was the cruel manner in which he had been treated by the French during his captivity. He mentioned among other incidents being brought out daily on to a sort of balcony of the prison, having the 'bonnet rouge' placed upon his head, and being shown to the mob below as a monster of iniquity. Then he told us the mob would hoot him and pelt him with cabbage stalks and stale eggs. He was very angry at so many French people being in the garrison. My mother ventured to say that the emigrants were of a very different stamp from that of the mob at Toulon. But he only avowed that his blood boiled at the sight of a Frenchman, and his first measure would be to drive them all out of the place. Shortly after he heard that we children were attending at Madame Cibon's house to learn the French language, and my mother explained to him how it came about, and the noble conduct of the Cibons. He listened attentively, and when she had finished her story, he turned to my father and said, 'Fyers, give the poor devils 100 dollars (£20) for me.' My father gladly fulfilled his benevolent command, and nothing more was heard of driving the emigrants from the Rock. On the contrary, all the respectable families were invited to his evening parties. . . .

"Major-General Robert Morse had been the Commanding Royal Engineer at Gibraltar for some years, and in 1795 he returned to England, leaving his wife and daughters to follow later. When they followed him however the ship they sailed in was captured by the French and carried

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into a French port, where I was told they were very badly treated. On General Morse's departure my father, as senior officer of the Corps at the station, became acting Commanding Royal Engineer, and was eventually confirmed in the appointment.

"I well remember our moving into the house appropriated to the Commanding Royal Engineer after Mrs. Morse and her daughters had sailed. It was a pretty place, built by General Sir William Green, and although we children enjoyed the bustle of the move, it was not without much regret that we left the old house, where we had lived for seven years. The 'new house,' as we called it, soon obliterated any regret for our old home, and I must describe it. The main street of Gibraltar is fairly wide, with lanes branching out of it on the mountain side, narrow and steep. Bell Lane, the quarters of the Royal Artillery, was to the left. Engineer Lane was narrow and dirty, and contained only two old houses. Midway down this lane were the large gates by which you entered our new premises; a rather steep ramp led to it; on the right hand of this ramp was a high wall, in which was a door giving access to a couple of rooms, which served as a cellar. The parterre was prettily laid out, the road wide enough for a carriage to drive round to the front door. A gate at the other end of the parterre opened out to a very steep hill, leading on the right to a portion of the Rock, enclosed in our demesne by a high wall, and on the left it descended to the stables and to the bombproof building, where, in case of need, the family might congregate in safety, and where also the valuable maps, plans, and models of the fortress might be stored in the event of a bombardment. . . ."

For some six years after the Fyers family had settled in the house of the Commanding Royal Engineer there is no information in the MS. At the end of that time the writer, who was in her seventeenth year, became engaged to be married to Mr. Cornelius Mann, then a lieutenant in the Royal Engineers and quartered at Gibraltar. He was the second son of Colonel Gother Mann, afterwards General and Colonel Commandant, R.E., and Inspector-General of Fortifications.

The remaining quotations from the MS. refer to the naval fight off Algeciras in 1801, of which the writer was a spectator, and to her marriage :—

"It was, I think, on the 6th July, 1801, that we were sitting at breakfast in a room which commanded a view of the bay and of a great part of the Straits, with the African coast and Cabrita Point in Spain, when my father, riding up, called to us. We ran out to the corridor, and he told us that English men-of-war were rounding Cabrita Point close in to the Spanish coast. . . . It certainly was a beautiful sight to see those magnificent ships, their white sails shining in the sun, and following each other at intervals. The breakfast room was soon deserted as we hastened to an eminence near the pluviometer, whence we had a perfect view of the town of Algeciras opposite and the whole of the coast on that side of the bay.

'The day was beautifully clear and fine. We were presently joined

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by several officers of the Royal Engineers—Mr. Mann,* Mr. Jones,† and others. We were not kept long in suspense as to the intention of the British squadron, for the ships began firing against the French ships of war at anchor and at the Spanish forts at Algeciras. The fire of our fleet was warmly returned both from the French ships and from the Spanish defences, including the little island‡ opposite the town of Algeciras. With what intense interest was the scene watched from our side of the bay. Every soul in the place seemed to have congregated either on the Line wall or on the heights, and the murmur of so many voices came to us like the sound of the sea waves."

It may be as well to explain here that the French admiral, Durand Linois, had been sent with a squadron from Toulon, consisting of the *Indomptable*, 80, *Formidable*, 80, *Desaix*, 74, and *Muiron* frigate, 38, to effect a junction at Cadiz with a French and a Spanish squadron there, and that his squadron had been seen from Gibraltar on the 1st July, working against a strong N.W.W. Learning that Cadiz was blockaded by a superior force, Rear-Admiral Linois bore up for Algeciras, and on the 4th July rounded Cabrita Point about 10 a.m., in sight of the British 14-gun sloop *Calpé*, Capt. the Hon. George H. L. Dundas. About 5.0 in the afternoon Linois came to with his squadron in front of the town of Algeciras. Dundas at once despatched Lieut. Janvarin to inform Rear-Admiral Sir James Saumarez, commanding the blockading squadron at Cadiz. This squadron consisted of seven ships of the line—the flagship *Cæsar*, 80, Capt. Jahleel Brenton; *Pompée*, 74, Capt. Sterling; *Spencer*, 74, Capt. Darby; *Venerable*, 74, Capt. Hood; *Superb*, 74, Capt. Keats; *Hannibal*, 74, Capt. Ferris; *Audacious*, 74, Capt. Peard; and the frigate *Thames* and brig *Pasley*.

Sir James Saumarez received the news at 2 a.m. on the 5th July, and immediately started with his squadron, except the *Superb*, for Algeciras. Variable light airs and calms delayed him, but at 7 a.m. on the 6th, the *Venerable* leading, opened Cabrita Point and saw the French ships warping further inshore to get completely under the protection of the shore batteries that defended the road. The signal was made from the flagship to engage the enemy as the ships arrived in succession.

The road of Algeciras is open and shallow. It was defended by Fort S. Garcia, a mile and a-half to the S.E. of the town, and between Fort S. Garcia and the town was another work opposite Isla Verda, upon which was a battery of seven long 24-pounders; on the other side of the town, three-quarters of a mile to the north, stood the battery of San Iago, mounting five long 18-pounders, and

* Lieut. Cornelius Mann.

† Lieut. John Thomas Jones, afterwards Major-General Sir J. T. Jones, Bart., K.C.B.

‡ Isla Verda.

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near this battery was Almirante Fort, or Tower. There were also 14 heavy gunboats.

The British ships, baffled by calms and light variable breezes, arrived at long intervals at the scene of action, and had to anchor in unfavourable conditions for attack to prevent their running aground. The *Hannibal* did get aground in trying to get into position to rake the French flagship, and eventually had to haul down her flag. There was a furious cannonade on both sides, but the British ships often lay exposed to the full effect of the fire from the Spanish forts and the French ships without being able, on account of the sudden calms, to bring a gun to bear on their enemy.

The MS. continues :—

"By the help of our glasses we were able to distinguish women and children climbing up the steep hills behind Algeciras to get out of the way of shot and shell. The smoke clearing away a little, we had the mortification of seeing that H.M.S. *Hannibal* had got ashore to the north of the little island and was of course *hors de combat*. The firing got heavier, and later on we were grieved to see H.M.S. *Pompée* disabled and being towed across the bay to Gibraltar Harbour, with her sails hanging covered with shot-holes. The loss of the help of these two ships and the damage done to the others were serious, and it was sad to see our squadron obliged to draw off greatly injured by the enemy's fire and make for Gibraltar.

"However, Englishmen are not the people to be disspirited by the first untoward circumstance. Sir James Saumarez, whose flag was hoisted on board H.M.S. *Cæsar*, Capt. Brenton, had the ship taken into port. She had suffered a good deal, but the repairs were begun at once and continued unremittingly."

The writer of the MS. does not say anything about what took place immediately after the action. The French admiral, Linois, while getting his grounded ships afloat, sent an express overland to Cadiz, imploring the Spanish and French admirals in Cadiz Harbour to come to his assistance before the British could get their ships repaired and renew the attack. Accordingly, on the 8th July, the Spanish admiral, Massaredo, with five Spanish and one French sail of the line, three frigates, and a lugger, came out of Cadiz Harbour and anchored in the outer road, ready for a start next morning. The movement was observed by H.M.S. *Superb*, cruising off the port, and when the combined squadron of Spanish and French ships sailed at daylight on the 9th, they were preceded by the British ships *Superb*, *Thames*, and the brig *Pasley*. Early in the afternoon the brig *Pasley*, with all sail crowded on, ran into Gibraltar with the signal for an enemy flying, and while the Spanish and French squadron was hauling round Cabrita Point, H.M.S. *Superb* and *Thames* anchored in the bay.

It was well understood at Gibraltar that the object of this

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reinforcement was to convoy Linois and his ships safely to Cadiz, and nothing could surpass the exertions of the British officers and men to get the damaged vessels ready for sea. The *Pompée* was in too bad a condition to leave any hope that she could be got ready in time. Her crew was therefore employed to assist in the repair of the other ships. The *Cæsar* lay in the Mole in so shattered a state that the admiral gave her up also, and shifting his flag to the *Audacious*, intended to distribute the crew of the *Cæsar* among the effective ships. Capt. Brenton asked that his crew might remain in the ship as long as possible, which was permitted. Then informing the men of the admiral's intention, all hands agreed to work day and night. On the 12th, when the enemy began to move, the *Cæsar* was still in the Mole, but taking in powder, shot, and shell, and other stores.

At 1 p.m. on the 12th the Spanish ships *Real Carlos* and *Hermenegildo*, of 112 guns each, were off Cabrita Point, and the rest of the enemy's ships were nearly all under way. Then H.M.S. *Cæsar* began to warp out of the Mole, her band playing "Come, cheer up, my lads, 'tis to Glory we steer," and the military band responded with "Britons, strike home." At 3 p.m. the *Cæsar*, passing under the stern of the *Audacious*, re-hoisted the admiral's flag and made the signal for the squadron to weigh and prepare for action.

To return to the MS. :—

"The combined Spanish and French fleet, knowing how much disabled our ships were, took advantage of the state of affairs to sail away out of the bay. The melancholy part of the affair proved to be that many Spanish persons of rank, with their wives and families, thinking they could not find a safer opportunity of returning to Cadiz, went on board the Spanish three-deckers (the *Real Carlos* and *Hermenegildo*).

"Sir James Saumarez was determined not to let his enemy escape, and the same day that the Allies sailed away the British fleet followed them. We went to our old station near the pluviometer to see them sail. The Line wall was again so densely crowded that nothing but human heads could be seen. The *Cæsar* was taking in ammunition up to the very last moment. As she left a shout arose from the assembled multitude such as I never heard before or since. Never was so animated a scene. The British ships were watched until they had fairly got into the straits and were hidden by Cabrita Point, and no one settled to anything that day. Our house was full of visitors from morning to night discussing the pursuit and the possible fight which might be going on close to us, almost under our eyes, and the probability of success to our gallant Admiral.

"The garrison continued that Sunday evening in a state of nervous excitement and anxious expectation. Then between 11 and 12 o'clock at night loud explosions were heard and the straits were illuminated by lurid flames, which lit up so brilliantly the southern end of the Rock that we were told the officers on guard could see to read by the light. . . .

"The next day passed without any news from the fleet or explanation of the explosion and fire. At length on the 14th July, to the joy of the

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garrison, the British squadron, entered the bay, bringing with it a prize. Again the crowd collected on the Line wall and the cheering was deafening. The ships were soon anchored, and the Admiral and his flag-captain came ashore. All the boys in the place followed them cheering and hurrahing. Sir James said he felt more grateful than he could express for his reception, for he knew that the cheers came from the heart. He and Capt. Brenton paid us a visit and sat a long time with us, and it may be easily imagined with what interest we heard all the details of the engagement.

"The fight had already begun when Capt. Keats, in the *Superb*, charged in between the French and Spanish three-deckers, and giving each a broadside passed on and engaged another ship. The unfortunate three-deckers, fancying in the dark they each had their enemy between them, blazed away at each other until they both took fire, burnt for some time, and then blew up. Then, indeed, there was an awful and distressing scene, poor wretches swimming for their lives, crowding into boats, laying hold of any floating spar or other article to escape being drowned.

"The English did their best to save as many as they could of these poor creatures, who afterwards spoke loudly in praise of the humane attention they had received from their enemies. . . ."

The above account of the engagement differs a little from that given in James's *Naval History*. There it is related that, the British squadron being in chase at 8.45 p.m., the Admiral hailed the *Superb* close astern of him, and directed Capt. Keats to make sail ahead and attack the enemy's ships, none of which were then visible. Immediately all sail was set in the *Superb*, and at 11 p.m. she was 3 miles ahead of the flagship. Shortly after she observed a Spanish three-decker (*Real Carlos*) about a point before her port beam, and a three and a two-decker (Spanish *Hermenegildo* and French *S. Antoine*) in a range with and on the port side of the former. The *Superb* shortened sail, and when about 300 yards from the *Real Carlos*, opened a broadside fire upon her. At the third broadside the *Real Carlos* was on fire, and the *Superb* ceased engaging her. Shortly after the *Real Carlos* came suddenly to the wind, and then drifted astern in evident confusion, she and her two nearest companions firing their guns in all directions. At about 12.15 a.m. on the 13th the *Real Carlos* blew up, but not until she had fallen on board of and set in a similar blaze the *San Hermenegildo*, who, having in the dark mistaken the *Real Carlos* for a foe, had been engaging her, and in another quarter of an hour the *Hermenegildo* also exploded. As the British squadron came up the *S. Antoine* surrendered.

It blew very hard during the night, and the pursuit of the rest of the combined squadron continued till daylight, when the wind fell. H.M.S. *Venerable* and the French *Formidable* were then engaged in a desperate conflict, but the former got on a shoal some 12 miles south of Cadiz. At 8 a.m. the *Cæsar* came up, and the *Audacious*

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and *Superb* following, the Spanish Admiral hauled up for Cadiz, where his ships were soon safely moored. Fortunately the weather continued calm, and the dismasted *Venerable* was got off the shoal and taken in tow by the *Thames*. The squadron got into Gibraltar on the 14th with the *S. Antoine* as a prize. Sir James Saumarez and his officers and men received the thanks of Parliament, and the Admiral was made a K.B. and granted a pension of £1,200 a year.

The day following the return of the fleet to Gibraltar after the victory was held as a day of rejoicing, and the victory was celebrated in many ways during the day and by illuminations at night. Now it so happened that this very day had been fixed some time before for the marriage of Miss Sarah Fyers to Lieut. Cornelius Mann, R.E. The lady writes of this :—

"As there was a special license for my marriage, the wedding took place in our drawing room in the evening. All the candles and lamps in the house were lit on account of the illuminations for the victory, adding not a little to the heat of a July evening at Gibraltar. The Governor, General O'Hara, had asked my father to allow him to give me away, and came attended by his aide-de-camp. General Wemys was also present and Capt. Brenton, R.N., who brought me a present from the Admiral, who was not well enough to come. Among the many friends present were my excellent governante, Madame Cibon, and her daughter. The Garrison Chaplain, the Rev. J. Hughes, performed the rite, and at the supper which followed General O'Hara made a fine speech to my husband."

After the conclusion of peace with Spain, Mrs. Mann writes :

"Capt. Brenton came to our quarters, which were close to my father's, begging us to go with him to Algeciras to call upon the Spanish Governor. We formed a pretty large party; besides my husband and myself, there were my pretty sister Charlotte[o] and Nanna Cibon, who was staying with us, dear Madame Cibon having died shortly after my marriage. We had a very pleasant row over, and were received by the Governor with the greatest civility. He walked about the town with us, and showed us the places where the houses had been struck by the shot and shell from our fleet, for although they had been repaired, the fresh brickwork made them very conspicuous. We accepted his invitation to dinner. He apologized for the want of time preventing him having the dinner in the English fashion, but that he had ordered that no garlic should be put into any of the dishes. We had an excellent dinner.

"During the war our ships used to be seriously annoyed by little Spanish gunboats. These boats used to come close under the English ships as they were entering the harbour and fire away without the ships being able to bring any of their guns to bear on them. There was one man especially who commanded one of these little boats who used to single

[o] Afterwards wife of Vice-Admiral James Young, of Barton End, Gloucestershire.

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out a ship Capt. Brenton was cruising about in, and the encounters were often very serious affairs. This man was admired, not only for his skill, but for his bravery and daring. After dinner Capt. Brenton enquired about the man and expressed a wish to see him. He was sent for, and was not long in making his appearance. He was a rough, weather-beaten looking man in the dress of a common sailor. He entered the room with a timidity one would hardly have expected from so brave a man. Capt. Brenton however soon reassured him. He rose from his chair, and advancing to meet the man, shook him heartily by the hand, told him he was a brave fellow, and that as they had often fought together they ought now to drink a glass of wine together, which they did, hob-nobbing in the old-fashioned style. It was curious to observe the sudden change in the man's countenance when Capt. Brenton received him so cordially. Indeed, all the Spaniards present seemed surprised at the condescension of the English captain, and his taking notice of the gunboatman from whom he had received so many injuries.

"We spent a delightful day and returned to the Rock in good time, but, alas, a lecture from my mother was awaiting me. In my ignorance and thoughtlessness I had left home in the morning without ordering dinner for the servants, and they had gone to make their complaint to my mother, who allowed them to join her own servants.

"Some months after the peace I took into my service an active young Spanish girl named Johanna, who was living at Algeciras at the time of the engagement in the Bay. She was able to give me an animated account of the consternation occasioned in the town by the appearance and attack of the British fleet. She said that all the families that could leave the place took shelter in the mountains. They rejoiced greatly in what they took to be the victory gained over the English, but the later encounter in the Straits was not known until long afterwards, she said.

"The *Cæsar* was stationed at Gibraltar for some time after the establishment of peace, and many excursions we had with Capt. Brenton and other officers of the Navy to the Cork Woods. Capt. Brenton, with my husband and Mr. Jones, rambled over the most difficult parts of the Rock, visiting caves which few had entered, and Capt. Brenton gave me some interesting sketches he had made of the interiors, especially of one which from its dangerous access was called 'Madman's Cave.'

"Soon after my marriage our dear old friend, General O'Hara, was seized with a serious illness, so that he was not able to sign my marriage certificate, which Mr. Douglas, the aide-de-camp, had delayed making out longer than he ought to have done. After many months of severe suffering he passed away, and we had to lament the death of our oldest and best friend."°

° Here the MS. ends. Sarah Mann survived her husband some years, and died at Brinstead, Isle of Wight, on 6th September, 1846. Their family was a large one.

(*To be continued*).

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TRANSCRIPT.

THE FINAL STRUGGLE FOR 203-METRE HILL AT PORT ARTHUR.

Translation of an article by Staff-Capt. Kostiushko in the March, April, and May numbers of the *Eenzhenernee Zhoornal.*

One of the most brilliant episodes in the Defence of Port Arthur, and incidentally in the military history of the 5th East Siberian Rifle Regiment, was the 10 days' fighting in November and December, 1904, on the position called by the Russians Visokaya Hill. This position received two separate attacks from the Japanese in September, from the 21st to the 24th inclusive, and again from the 28th November to the 6th December. In September the Japanese were repulsed by the heroic action of certain distinguished individuals; in November and December countless brilliant actions were performed, but the Russians did not succeed in holding the hill.

The September fighting has been described often, and its details are fairly well known; all that is known about the second attack is that the Japanese pulverized the hill with 11″ shell, and after a desperate resistance took it; but of the details of the defence, how it was carried out, to whom the credit for such obstinacy is due, what heroic deeds were performed in the course of the 10 days' struggle, and by whom, little is known. Even in the Court of Enquiry on the Defence of Port Arthur, when less important events which occurred on the right flank were described in great detail, scarcely a word was said about the final struggle for Visokaya Hill, although it was this fighting particularly which brought about the fall of the fortress.

With the desire therefore of doing justice to the gallant, but hitherto forgotten, defenders of Visokaya Hill, it is proposed to describe in comparatively few lines the events which occurred on each day of this historic struggle, and to dwell at greater length on the noteworthy incidents and heroic deeds of individuals which occurred during the fighting.

It may be allowed with justice that each of the general officers concerned in the defence sought out every device and used every endeavour to keep the hill. General Kondratenko always watching the fight personally, and so attentively that nothing escaped him, sending up in good time reinforcements, food, grenades, cartridges, in fact, everything that was necessary; General Irman almost daily visiting the hill, and by his reckless bravery, better suited to the ardour of youth, encouraging and charming all; and General Stessel carefully following

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the fighting, at the critical moment placing General Tretyakov in immediate charge of the defence, cheering the troops with kind messages and rewarding on the spot those who distinguished themselves. In a word, each did what he could, but the heaviest and most difficult part, and at the same time the most important, the immediate responsibility for the defence, fell to General Tretyakov, the commandant of the 5th East Siberian Rifle Regiment, who remained on the hill for six days continuously, again and again leading the troops to the attack, by his personal skill doing great deeds with small numbers, and repeatedly repulsing an enemy who outnumbered his men fully ten times over.

But in publishing the present account one reservation is necessary. The reader must not imagine that it is either perfect or complete; he must understand that, in addition to the whole of the 5th Regiment, many other troops took part in the defence, combatant, non-combatant, and composite companies of other regiments, sailors, town guards, and hospital detachments. In a word, all who were found alive in Port Arthur, and could handle a gun, were collected by Stessel and Kondratenko, and despatched to Visokaya Hill. Consequently, from first to last, there were on this ill-fated hill representatives of not less than 80 different companies and detachments. In some cases even parties of a few men each were joined together in twos and threes, and were sent off to the hill, where they melted away with appalling rapidity and were seldom heard of again. It is, consequently, exceedingly difficult to fix exactly when certain companies were on the hill, and how they were disposed, and to obtain all the information necessary for a complete and accurate description of the fighting. In an earnest desire to give full credit to all, the writer has supplemented his personal observations with information obtained from various reports and from the evidence of others who were present, and, consequently, if any errors or omissions are to be found in this account, they were certainly not premeditated.

Furthermore, he feels sure that it would be difficult to find a more accurate account of this historic fighting, or anyone better qualified than himself to make it out, for the following reasons:—

(i.). That through him as Adjutant, 5th East Siberian Rifle Regiment, almost all the reports and orders affecting the section attacked passed.

(ii.). That the descriptions of the fighting sent in subsequently by the companies of the 5th Regiment also passed through his hands.

(iii.). That, not satisfied with these official details, he also collected many statements from men who took part in the fighting, and

(iv.). That he himself also took part in it.

Description of Visokaya Hill and its Defences.

The town of Port Arthur consisted of two parts—the western, called the New Town, and the eastern, called the Old Town.

On the north-west of the New Town there lay a low ridge of hills called the Jagged Hills.

The highest point of this ridge attained an elevation of 700′ (203 metres)

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and lay about 2 miles from the New Town in the direction of Louisa Bay, *i.e.*, west-north-west,

Its two-pointed summit and very steep sides gave it the appearance from a distance of a two-humped camel. The Russians called it "Visokaya" (great), and the Japanese "203-Metre Hill."

The approach to Visokaya, and also to Flat and False Hills, lay along a ravine named after the tea house of the 11th Regiment, which was built before the war, at the north-west extremity of the New Town, in the mouth of the ravine. Being well covered along its whole extent by low but generally steep hills, and therefore well suited for the concealed movement of troops, the Tea Ravine formed a safe approach to the very foot of Visokaya Hill, which itself protected it on the third or western side. This ravine in places attained a width of 100 paces, but it was generally considerably narrower. A cart road leading to Visokaya Hill ran along it.

Visokaya Hill attracted notice as being a fine and naturally strong position. It was higher than all the neighbouring hills except Lyaoteshan, and commanded both the surrounding country and also the forts of the centre and eastern fronts of Port Arthur. It was undoubtedly the tactical key of the west front of the land defence, and to a certain extent that of the whole Port Arthur position.

Besides this a wide view could be obtained from it in all directions; many of the buildings of the Old Town could be seen from it, while the whole extent of the Tea Ravine, the whole of the New Town and the inner roadstead where the fleet had taken shelter, lay at its feet.

On the 4th June, 1904, the whole extent of the Jagged Hills, which included Division, Three-Headed, Side, Forward, Angle, Saddle, Deadly, Long, Flat, Visokaya, False, and Intermediate Hills, was placed under the command of the commandant of the 5th Regiment, and not till then was their fortification taken in hand seriously.

Previous to this Staff-Capt. Smirnov, of the Fortress Sapper Company, had begun a trench low down the front slope of Visokaya. On the left it had been excavated deep enough to allow of firing in the kneeling position, but on the right it was only marked out. In addition to this trench, Smirnov intended to put a battery for two 6″ guns on the right peak, and as the surface of the hill near the summit consisted of an almost naked slope of quartz, he hired Chinamen to collect earth at the foot and carry it up the hill in baskets on small donkeys. But though 50 men were thus employed daily, the work made little progress.

When Colonel Tretyakov took over charge, he reconnoitred the hill with Capt. Stempnevski I., Staff-Capt. Belozerov, Lieut. Gleb-Koshanski, and other officers of his regiment, and decided that Capt. Smirnov's trench was useless, as it was too wide, had no traverses, and was placed so low down the hill that it was commanded by several hills which were considerably lower than Visokaya. It was therefore decided to make a new trench considerably higher up, and to use the old trench as an obstacle.

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The 2nd and 4th Companies, 5th Regiment, were detailed as working parties, and these formed the original garrison of the hill. Capt. Stempnevski I., of the 2nd Company, was made commandant. Henceforth the work proceeded briskly, the men working with pick, crowbar. and shovel each day, from 6 to 11.30 a.m., and after dinner from 2 to 7 p.m. Stempnevski was the first to reach the hill each day and the last to leave it at night, and after 4th August he stayed there altogether.

Colonel Tretyakov, when riding round his section once and often twice a day, usually spent a long time on Visokaya Hill and paid special attention to its fortification. General Kondratenko also came there fairly often, and was well pleased with the rapidity and excellence of the work. The advice and directions of these senior officers were keenly and skilfully applied by Stempnevski. The men worked unceasingly on holidays and working days, in spite of rain, heat, and weariness, and by August had completed the following works:—

(i.). A ring trench, 3,500′ in length, of a profile suitable for firing standing in the bottom of the trench, with traverses, strong blindages, and hoods in many places. Owing to the great steepness of the hill, it was found that a parapet would render it impossible to sweep the slopes with fire, and would help to form dead ground. At first one was made, but later on it was removed and the trench excavated deeper. Some idea of the difficulty of this work can be formed when it is understood that it was all excavated with pick, crowbar, and shovel only.

(ii.). On the left flank, between Visokaya and False Hills, Capt. Smirnov's lower trench was converted into a ditch of considerable width and depth; but the rest of it, for want of labour and time, was simply brought under fire from the upper trench by ramping its rear slope, so that the enemy could not take cover in it.

(iii.). On the right peak the battery was completed and armed with two 6″ guns.

(iv.). On the saddle a battery was made for two field guns.

(v.). On the reverse slope of the right flank (heavy gun) battery a magazine was excavated.

The artillery on Visokaya Hill was used only in August. At this time the field guns were so overpowered by Japanese shells that they had to be removed, and were seen no more on Visokaya Hill. Of the 6″ guns, one was put out of action and the other had its carriage damaged, but they were not taken away, although they were of no use on Visokaya (for they could only fire at long ranges), as this would have required many men for whom more useful work could be found elsewhere. And so they were left on the hill, and even in their damaged state are said to have fired a few rounds in the September fighting.

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After August the fortifications were improved, blindages and hoods were strengthened, and fresh ones were made (see *Figs.* 1 and 2).

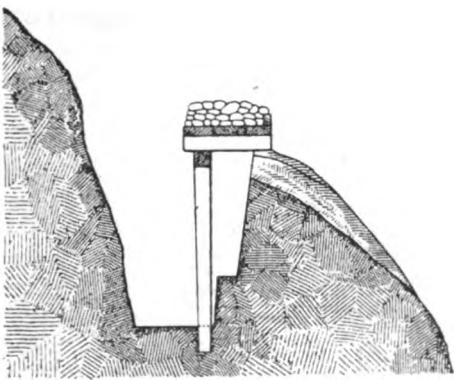

FIG. 1.—*Original Hood.*

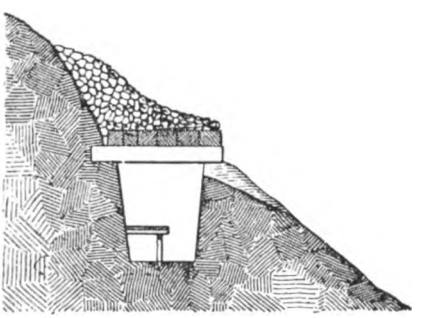

FIG. 2.—*Original Blindage.*

From the 21st to 24th September the Japanese assaulted Visokaya and Long Hills; they took the latter, but were repulsed from Visokaya with enormous losses. The steep slopes of the hill were thickly strewn with Japanese corpses, and it took five or six nights to gather in the slain. Some of the corpses, which are said to have numbered 1,761, were carried down the reverse slope for burial, and with the rest they filled Smirnov's trench, which they afterwards covered up with earth.

The September fighting revealed certain faults in the blindages and hoods. The latter had too large loopholes, so that in some cases men using them were even struck by shrapnel bullets. The blindages were not really proof against the shells of field guns, while 6″ shells completely destroyed one and seriously damaged four others.

This experience was made good use of, and by November the blindages were greatly strengthened. Each crossbeam was propped in the middle

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with an 8″ upright (see *Fig.* 3), and on the roofs were laid steel plates. about ½″ in thickness, which were obtained by the sailors, or a row of rails laid flat, and in two or three cases a double row of rails laid upright. Above this was placed a layer of stones 14″ to 28″ in thickness. Thus strengthened the blindages were proof against 6″ and even against Shimoze shells.

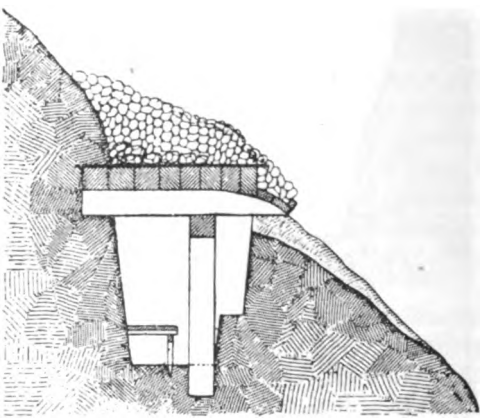

FIG. 3.—*Improved Blindage.*

The hoods were also improved (see *Fig.* 4), so that the men could no longer be struck by shrapnel bullets through the loopholes.

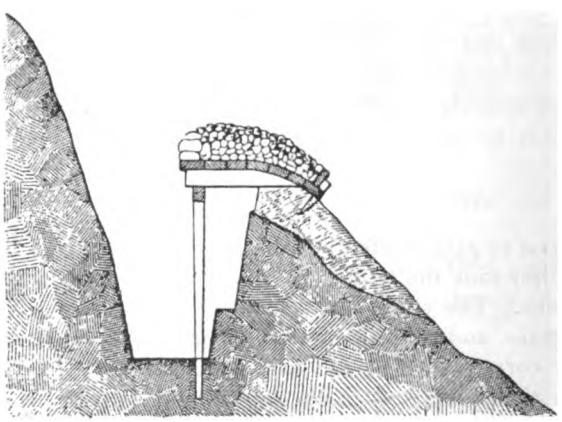

FIG. 4.—*Improved Hood.*

The September fighting also showed the necessity of fortifying the left peak with a redoubt. In spite of the fact that this peak consisted of a smooth rocky slope, yet by November a strong redoubt had been excavated there, with a trench 7′ deep and 42″ wide, provided with traverses and blindages, of which a specially strong one was provided in

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the centre for the commandant. The roof of this blindage was protected by a double layer of rails and 42″ of stones, and apparently it was not wrecked even by 11″ shells. Communication trenches led into this blindage from both sides.

The battery on the right peak was also converted into a redoubt, and was connected with the left peak by a trench, in depth equal to a man's height. This trench passed through the field gun battery, and here its profile was made suitable for firing, standing, from a step.

The ring trench was also strengthened to this profile. Around the ring trench, at a distance of 20 to 60 paces, according to the ground, was made a wire entanglement, and another was made above the ring trench, at 15 to 20 paces in front of the left redoubt. Each was about 14′ in width, but the upper one was further strengthened by abattis, which was brought up from the original position, which lay between Forts Nos. 4 and 5.

For use in bringing up reinforcements, and thus reducing losses, the following communication trenches, which varied in depth from 6′ to 7′, were excavated:—Two to the trench connecting the two peaks, one from the trench in the right battery towards the magazine, and one, blinded, from the connecting trench to the front part of the ring trench.

By November the garrison of Visokaya Hill consisted of the 2nd, 4th, and 6th Companies of the 5th Regiment, the 7th Company, 14th Regiment, and the 4th Company, 15th Regiment. One company was given a rest each day.

Work went on uninterruptedly and especially by night. Some of the men were employed in dragging up the hill beams, joists, planks, rails, steel plates, bags, etc.; others not only carved the rock with picks, crowbars, and shovels, but also blasted it out with *rak-a-rok*, which greatly helped on the work. A special Sapper officer was detailed to superintend.

General Tretyakov, as before, visited the hill daily, and sometimes twice a day. He chiefly gave advice and orders for carrying out fresh work. Other senior officers also came, notably Generals Irman and Kondratenko. During October and November Colonel Dubitski, the engineer, also came. All gave valuable advice, and Colonel Dubitski also usefully accelerated the delivery of building materials and tools.

As the garrison of the hill could not supply sufficient men to cope with this tremendous work, parties were daily sent from certain companies in the reserve, and when none of these were available, men were brought from the less important posts, and sometimes even from False Hill.

As an example of the care with which the command on Visokaya Hill was managed, it may be mentioned that water for the positions was drawn from a well at the headquarters of the 5th Regiment, and was transported by night in barrels, and in other parts was carried up the hills in buckets arranged for that purpose. But at Visokaya a steam pumping plant was installed, by which the water brought up in barrels was driven up the hill.

Several men of the garrison, finding how rapidly the rock could be excavated with *rak-a-rok*, set to work to excavate for themselves caves in the rock. One of the best caves belonged to Staff-Capt. Olander, commanding the 4th Company, 5th Regiment. Excavated at the bottom of

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the rear side of the trench, this cave formed a long narrow room, in height equal to the height of a man. The electricians also had a cave, and also some of the sergeant-majors, while others were made in several blindages.

The 11″ shells were unable to wreck these caves, but could and did block up their entrances.

These caves showed that it is possible to excavate in a hill not only roomy and safe shelters for supports, but also tunnels leading to threatened points. Between June and November there would have been plenty of time to do this, but unfortunately the *rak-a-rok* was thought of too late.

II.—Works on False, Flat, and Division Hills and the Original Position.

False Hill, which had been entrenched by its own garrison since May, stood to the left and somewhat behind Visokaya. At the time of the August fighting its works consisted of shallow trenches, and on its summit had been placed two spars, the tarred ends of which projected outwards, and were intended to look like the muzzles of guns. It was hoped by this means to deceive the enemy and make them uncertain as to whether the firing was carried on from here or from Visokaya, and from these false guns the hill received its name.

During the September attack this hill brought a flanking fire to bear upon the Japanese and contributed largely to their repulse.

By November its works took the form of a redoubt, with profile for firing standing from a step, provided with traverses and blindages. The blindages were practically the same as those on Visokaya had been in September. Warming places were provided at intervals in the rear slope of the trenches.

The works on Intermediate Hill were of equal strength to those on False Hill, and were shaped like a wide lunette—a trench with bent-back flanks.

Flat Hill lay to the right of Visokaya, and was occupied after the fall of Long Hill on 22nd September. Its defences were not begun till after this date, but nevertheless by November it had been provided with a trench, on the left flank in two tiers, for firing standing from a step, with traverses, hoods, and warmed shelters; and on the summit was placed a redoubt, named Stony Redoubt, of similar profile to the trench and provided with traverses and hoods. In the redoubt there were strong blindages for the company and a separate one for the commander. These were made by covering over a trench with two layers of beams and laying about 28″ thickness of stones on the top.

Flat Hill flanked the approaches to Visokaya, and its preservation was essential to the safety of the latter.

Division Hill (between Flat Hill and Fort No. 4) was so named because it was intended to put a division of field artillery there, and was actually used for this purpose in August, emplacements having been provided meanwhile. By November it was entrenched as strongly as False Hill, but special attention had to be paid to its vulnerability from the left flank, and its trenches were therefore divided into sections, and two subsidiary trenches at right angles to the main ones were provided.

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The line of works between the Forts Nos. 4 and 5, *i.e.*, Two-Angled and New Lunettes, Fougasse Knoll, Red Hill, etc., are called the "original position," because up to May, 1904, it was the only line prepared for defence in this section. It was made by the engineers probably at the same time as the forts, and as a position was far from satisfactory, either from a tactical or from a fortification point of view. It was protected by trenches of profiles in places suitable for firing standing from steps and in places for standing in the bottom of the trench, with traverses only in places and light blindages.

In all the defences the firing positions were provided with loopholes under the hoods. So long as the Japanese remained at a distance these loopholes were satisfactory, but by October, as the Japanese advanced their saps, the 8″ to 10″ openings became dangerous, and many men using them received fatal wounds in the head. This was afterwards counteracted by hanging curtains behind the loopholes and raising them cautiously when the latter were occupied for firing.

One day the troops returning from a successful sortie brought back a Japanese loophole plate, made of ½″ steel, with a cross-shaped opening in the middle for convenience of aiming and firing.

At the request of General Tretyakov, Colonel Dubitski prepared some plates of slightly modified design for the Russian trenches. These plates were rectangular, 8¾″ in height, and a little less in base measurement, while the vertical slots in the cross-shaped openings were made somewhat longer than in the Japanese plates, to give greater freedom in firing down the steep slopes of the hills. In all, 100 of these plates were supplied, of which 75 were allotted to Visokaya and 25 to Division Hill.

The fact that the openings on these plates were very difficult to hit induced greater steadiness in those using these loopholes. The men also took to protecting the loopholes for which there were no plates with stones. By this means the size of the loopholes was reduced, but not to the same extent as with the loophole plates.

Previous to the September attacks a mining apparatus had been established on Visokaya, but it proved useless, as it was put out of action by the first shells, and was afterwards taken away.

There were four machine guns on Visokaya and two more on Flat Hill. The mountings were found to be very bulky and inconvenient, and the men threw them away and rested the guns directly on the parapet. This not proving quite satisfactory, a trough was designed by Ensign Ermakov, from which the guns worked splendidly. All the same, the machine guns on Visokaya were of little effect, as they were all put out of action by the 1st December, and took no part in repelling the final attacks.

After their ill-success in September, the Japanese advanced against Visokaya Hill (in every sense a *field* fortification) by patient sapping, and by the time of the November assaults had obtained the following results :—

(1). A sap, with two heads, on the left flank of Visokaya, clearing the wire entanglement, had arrived within 30 paces of the ring trench, and ended in a parallel.

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(2). A sap in the centre had arrived within 150 to 200 paces of the ring trench.

(3). A sap on the right flank of Visokaya had arrived within 150 to 200 paces of the ring trench, and ended in dead ground, formed by the steepness of the hill at this point. From here the Japanese could get to the trench safely, but to reach it they had with great difficulty to scale the almost perpendicular cliff. This dead ground proved very treacherous to the Russians.

And lastly (4), a branch from this last sap came within 150 to 200 paces of the trenches on Flat Hill.

A sap was also driven against the left flank of Division Hill, but as this attack was not pressed it is unimportant.

III.—Garrison and Command.

The garrison of Port Arthur consisted of the following units:—

5th E. Siberian Rifle Regiment (detached from the 4th E. Siberian Rifle Division) of 11 companies (the 12th formed part of the Consular Guard in Pekin), and mounted volunteer detachments.

4th E. Siberian Rifle Division, commanded by Lieut.-General Fok—13th, 14th, 15th, and 16th E. Siberian Rifle Regiments, each of 12 companies, and 1 mounted volunteer detachment.

7th E. Siberian Rifle Division, commanded by Major-General Kondratenko—25th, 26th, 27th, and 28th E. Siberian Rifle Regiments, each of 12 companies.

3rd E. Siberian Rifle Reserve Battalion—4 companies.
4th " " " " 4 "
7th " " " " 4 "

At the beginning of the war each regiment was made up with reservists to approximately 3,000 men. As the companies were considered overcrowded, it was decided to separate out the volunteer detachments, to form one, two, or three *foot* volunteer detachments, according to the number of battalions in each regiment.

A sotnia of the 1st Upper Udinsk Cossack Regiment.

4th E. Siberian Rifled Artillery Brigade—4 8-gun batteries.

7th " " " " 3 " and fortress artillery.

The Commander-in-Chief at Port Arthur was General Stessel, commandant of the Kwantung fortified rayon. His second in command was Lieutenant-General Smirnov.

The defence of Port Arthur was divided into two main sections—sea and land. The latter was entrusted to General Kondratenko.

The line of land defence was divided into three parts:—(1), The Eastern Front (right flank); (2), Northern Front (centre); and (3), Western Front (left flank), from Fort No. 4 to Pigeon Bay inclusive. The commander of the Western Front was Colonel Irman, commanding

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4th E. Siberian Rifled Artillery Brigade. His section was divided into divisions, and the commander of the 1st Division was Colonel Tretyakov, commandant of the 5th Regiment. Colonels Irman and Tretyakov were of equal rank, Tretyakov being senior as a colonel and Irman senior as a brigadier. Both were promoted major-generals in October, 1904, but they were unaware of the fact and earned their fame in this fighting as colonels, and not as generals.

In the 1st Division were included the following positions :—

1. Fort No. 5.
2. The line of trenches in the Original Position between Forts Nos. 4 and 5.
3. Everything in rear of this as far as the New Town.
4. The Jagged Hills lying to the front, of which in November there were occupied :—Division Hill, Flat Hill, Visokaya, False, and Intermediate Hills, each of which had its separate garrison and commandant immediately under the orders of General Tretyakov.

The staffs were designated as follows :—

General Stessel's Staff	The Rayon Staff.
„ Smirnov's Staff	The Fortress Staff.
„ Kondratenko's Staff ...	The Land Front Staff.
„ Irman's Staff	The 5th Regiment Staff.
„ Tretyakov's Staff... ...	

This last staff was located in the Tea Ravine, in rear of Fougasse Knoll. The rest lived in the town.

Urgent reports and orders were sent by telephone. The 5th Regiment Staff had four telephones :—(1), To Fort No. 4 and Entrenchment No. 4; (2), to the town; (3), to the positions on Visokaya, False, Flat, and Division Hills; and (4), wandering.

For discipline, the 5th Regiment was under the orders of Generals Irman and Tretyakov, but for supply it was under General Fok, as commandant of the division to which the regiment was attached. This led to considerable inconvenience.

The first commandant of Visokaya, as already mentioned, was Capt. Stanislav Julianovich Stempnevski I., commanding 2nd Company, a man in the highest degree hardworking, painstaking, and brave. His service on Visokaya Hill presented a continuous round of courage, hard work, and privation. His work was repeatedly noticed in orders during August and September by Generals Kondratenko, Irman, and Stessel.

Visokaya Hill, as already mentioned, was a most important position and required a commandant who should be always on the *qui vive*, always prepared to resist the enemy. Such tension, combined with the constant danger and anxiety over the fortifying and guarding of the hill, greatly affected the commandant, especially during the fighting. In consequence of this, and although he knew him to be always brave, energetic, and cool-headed, General Kondratenko decided to appoint a second officer,

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who should share the command with Stempnevski, each holding it in turn for a period of 48 hours.

The 5th Regiment always did their best to merit the special consideration and trust which General Kondratenko placed in it, and which the dead hero repeatedly expressed to the regiment, and of which the latter was very proud. Referring to the choice of a second commandant of Visokaya Hill, he said: "I wish both commandants and not less than half of the garrison to be from the 5th Regiment." Though he well knew that in the preceding battles the regiment had lost more than 30 officers, killed or died of wounds, that the companies were all commanded by lieutenants, sub-lieutenants, and even ensigns, and that consequently there was no great choice, and though he recognized the inconvenience of subordinating commanders of companies which came to join the garrison of the hill, sometimes grey-haired captains of other regiments, to a commandant of half their seniority from among the company commanders of the 5th Regiment, yet General Kondratenko remained firm in his opinion and repeated: "The 5th Regiment are all heroes! I demand that both commandants and not less than half the garrison shall be of the 5th Regiment. Then I shall be content."

At first Capt. Stempnevski was relieved by Staff-Capt. Sichev, commanding the 6th Company, during the September fighting. After two days' struggle, the 2nd Company (Stempnevski's) had lost three-quarters of its strength and presented a mere handful of exhausted men, half of them wounded, and urgently requiring relief and rest. While considering the men it was impossible to overlook their commander. The 6th Company was sent up, and their commander, Sichev, took up the command of the hill. The Japanese were repulsed, and Sichev was decorated with the 4th Class of the Order of St. George.

From the 23rd September to the 31st October the relief of commandants was carried out regularly every two days.

Having taken up the command on the latter date, on the 2nd November Stempnevski refused to be relieved until the Japanese, who were attacking the hill on that day and the day before, should finally leave the place. The reason for this refusal was that in the previous fighting Stempnevski had been on the hill and had taken an active part in repulsing the Japanese, and together with Sichev had been recommended for a decoration. But General Fok had struck out his name, probably because he had been relieved during the fighting. Stempnevski was much hurt, and looked forward to the next attack on the hill to prove himself worthy of this high reward.

On hearing of his resolve, General Tretyakov informed him by telephone that he never doubted his courage, and that this was confirmed by his nomination as commandant of the hill, and that his resolve would be reported to the proper quarter.

On the 3rd November Sichev was wounded, although only slightly, by splinters of a shell which burst in the New Town, and was unable to relieve Stempnevski. In his place there was detailed an exceedingly gallant officer, Staff-Capt. Belozerov, commanding the 3rd Company, who had gained distinction in the previous fighting for courage and

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presence of mind. Thus in the retirement from Kinchow, while moving by night through a narrow gorge in the Mid-Arthur road, disorder arose in the baggage train from the unfounded rumour that the Japanese cavalry were following in pursuit. At the same time the inhabitants of Dalny began to join the column, bringing their possessions in Chinese carts. The more panic-stricken of these, trying to push forward in the narrow road, began falling down themselves and knocking down others, so that the whole convoy would have been rapidly in disorder had not its commandant, Belozerov, worked with a will, with voice and whip, and sparing none, rapidly restored order.

In the fighting on Angle Hill on the 21st and 22nd August he again distinguished himself. His 3rd Company lost 70 per cent. of its strength in repulsing the furious attacks of the Japanese, and he himself was always in the post of danger urging on his men. On the 22nd August, having been nominated commandant of that hill, in the place of the wounded Colonel Lisaevski, he personally several times led the reinforcements in counter-attack, repulsing an enemy ten times his strength, until he was wounded in the chest by a shrapnel bullet. Within little more than a month he was convalescent and again at the head of his company, then posted on Division Hill.

Generals Kondratenko, Irman, and Tretyakov, who had witnessed the fighting at Angle Hill, offered Belozerov the honourable post of joint-commandant of Visokaya Hill, which he willingly accepted.

At the beginning of the fighting the garrison of Visokaya consisted of the following :—

5th Regiment—2nd Company, 98 men.
4th Company, 103 men.
6th Company, 121 men.
14th Regiment—7th Company, 108 men.
15th Regiment—4th Company, 174 men.
Machine gun detachment (sailors).
Detachment of the Kwangtung Sapper Company.

One company was withdrawn for rest every two days. At the time of the fighting, the 7th Company, 14th Regiment, was resting.

The garrison of False Hill consisted of the following :—

5th Regiment—8th Company, 138 men.
11th Company, 148 men.

The commandant of False Hill, appointed in August, was Staff-Capt. Marchenko.

The garrison of Division Hill consisted of the following :—

5th Regiment—3rd Company, 137 men.
5th Company, 89 men.
7th Company, 182 men.
Portions of 2nd and 3rd Foot Volunteer Detachments, 93 men.
15th Regiment—5th Company, 96 men.
27th Regiment—9th Company, 133 men.

As commandant, Capt. Stempnevski II. was appointed in August.

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The garrison of Flat Hill consisted of the following :—

5th Regiment—9th Company, 152 men.
10th Company, 152 men.
27th Regiment—4th Company, 108 men.
5th Company, 138 men.
8th Company, 118 men.
11th Company, 128 men.
Composite Company, 148 men.
Volunteer Detachment, 91 men.

From October the commandant of Flat Hill was Lieut.-Colonel Budyanski, 27th Regiment.

Intermediate Hill was occupied by 10th Company, 26th Regiment, more than 160 men, and its commander, Staff-Capt. Lax, was commandant.

The original position was occupied only during the fighting, and at other times was protected only by guards, who were posted in two places, on roads.

The following troops remained in reserve with the Staff of 5th Regiment, in the Artillery Barracks in Tea-House Ravine :—

5th Regiment, 12th Company, 112 men.

The 7th Company, 14th Regiment, were resting, and with the colours of 5th Regiment was 1 section, 11th Company, 22 men.

IV.—Causes which Obliged the Japanese to Persist in Attacking Visokaya Hill.

At the end of October the squadrons of Admirals Rozhdestvenski and Nobogatov were approaching Madagaskar, with a view to uniting and together moving into the waters of the Pacific.

This circumstance caused alarm among the Japanese, because the approaching Baltic squadrons, combined with the remaining uninjured ships of the Port Arthur and Vladivostok squadrons, would present a formidable strength. Therefore the Japanese Naval Administration urged the army besieging Port Arthur to take it without delay, or at any rate to seize positions from which they could destroy the fleet which was taking shelter there.

In November this urgency became so insistent that the army of General Nogi received a definite order to advance to the attack, in spite of the incompleteness of its preparations.

In addition to the three infantry divisions and the two detached infantry brigades which had hitherto been before Port Arthur, in October the 10th Brigade, composed of men of the 2nd call, arrived from Japan, and about the middle of November the 7th Infantry Division, which had as yet seen no service, began to disembark at Dalny.

An English correspondent, at that time with the Japanese before Port Arthur, writes of this division that it was composed of young fresh troops recruited in the Island of Hokkaido, and reputed the best and bravest of

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the whole Japanese Army. Their arrival brought the strength of the besieging army up to close upon 100,000 men, including 24 infantry regiments.

With this force General Nogi again tried to take Port Arthur by assault, and on the 28th November, after several days' bombardment, the Japanese attack was carried out on the region of Forts Nos. 2 and 3.

Besides warning each soldier in this attack that he must be prepared to go to certain death for the attainment of the common object, the following is an example of the orders issued by the Japanese commanders :—

"Order of General Nakamura to a party of 2,000 volunteers who had engaged as a forlorn hope to work down the Lunho Valley :—

"The object of our detachment is to cut in two the Port Arthur defences. Not a man must hope to return alive. If I fall, Colonel Vatanabe will take my place; if he shares the same fate, the command will pass to Lieut.-Colonel Okuno. Every officer, whatever his rank, must appoint himself his successor. The fighting will be carried out chiefly with the bayonet. However murderous the enemy's fire, our men must not reply with a single shot until we are established in their lines. The officers are permitted to slay any men who, without cause, straggle, leave the ranks, or fall back." The story of the failure of this gallant party is well known and need not be repeated here.

In the course of 15 hours' continuous fighting the Japanese lost 10,000 men and failed to obtain the smallest success; not a trench was lost. From this they learnt that the hour had not yet come for the fall of these forts, and gave up hope in the early capture of Port Arthur.

On previous occasions, after their unsuccessful attacks, they had usually spent three or four weeks in preparation for a new attack; but in this case they were obliged to carry forward the attack without delay. The orders from Tokyo were peremptory, and Generals Fukushima and Kodama were sent by Marshal Oyama, the Commander-in-Chief of the Japanese Armies, to the headquarters of the besieging force to see that they were carried out.

And therefore, after giving up hope of the early fall of the fortress, General Nogi was obliged to push forward assaults with the object of capturing positions from which he could destroy the Russian fleet.

As Visokaya Hill was, if not the only, at any rate the most suitable position for carrying out this object, it forthwith attracted all the fire, the attention, energy, and the main forces of the Japanese.

V.—Fighting from 27th November to 7th December.

During this period the weather was settled, the days almost always bright and cool, with the wind blowing generally from the south-west, and the nights dark and cold (3° to 5° *Reaumer*).

On the 27th November the Japanese on the western front were largely reinforced, especially in front of the section commanded by Capt. Romanovski, where they pressed in the Russian mounted parties and tried to break through them, but were stopped by the timely arrival of reinforcements and the skilful and successful dispositions of Capt. Romanovski.

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In the night of the 27th—28th November a Japanese force of not less than a battalion of infantry concentrated near Pigeon Bay, in front of a position held by Staff-Capt. Soloviev, with a composite company of the 11th and 12th Regiments (collected from the depôt of these regiments, which was in Port Arthur) and the foot volunteer party of the 28th Regiment, under Lieut. Mikheev, in all about 300 men, and forthwith attacked it.

It should be mentioned that the repulse of the September attacks was greatly assisted by the action of a section of field artillery under Staff-Capt. Yasenski, which moved out from the direction of Pigeon Bay and, by its unexpected and well-aimed fire, dispersed about a brigade of reserves at the foot of Visokaya Hill. To prevent this occurring again, the Japanese hoped to take the position at Pigeon Bay before again attacking Visokaya.

After a desperate struggle, the Japanese, at about 3 a.m. on the morning of the 28th, succeeded in breaking through and capturing the most forward knoll; but the attack on the main position was repulsed with grenades and rifle fire. The artillery from Lieut. Erofeev's position assisted in obtaining this result.

In the hope of driving the Japanese from the front knoll, Staff-Capt. Soloviev at dawn carried out a counter-attack, in which he was killed; but the knoll remained in the hands of the Japanese.

(*To be continued*).

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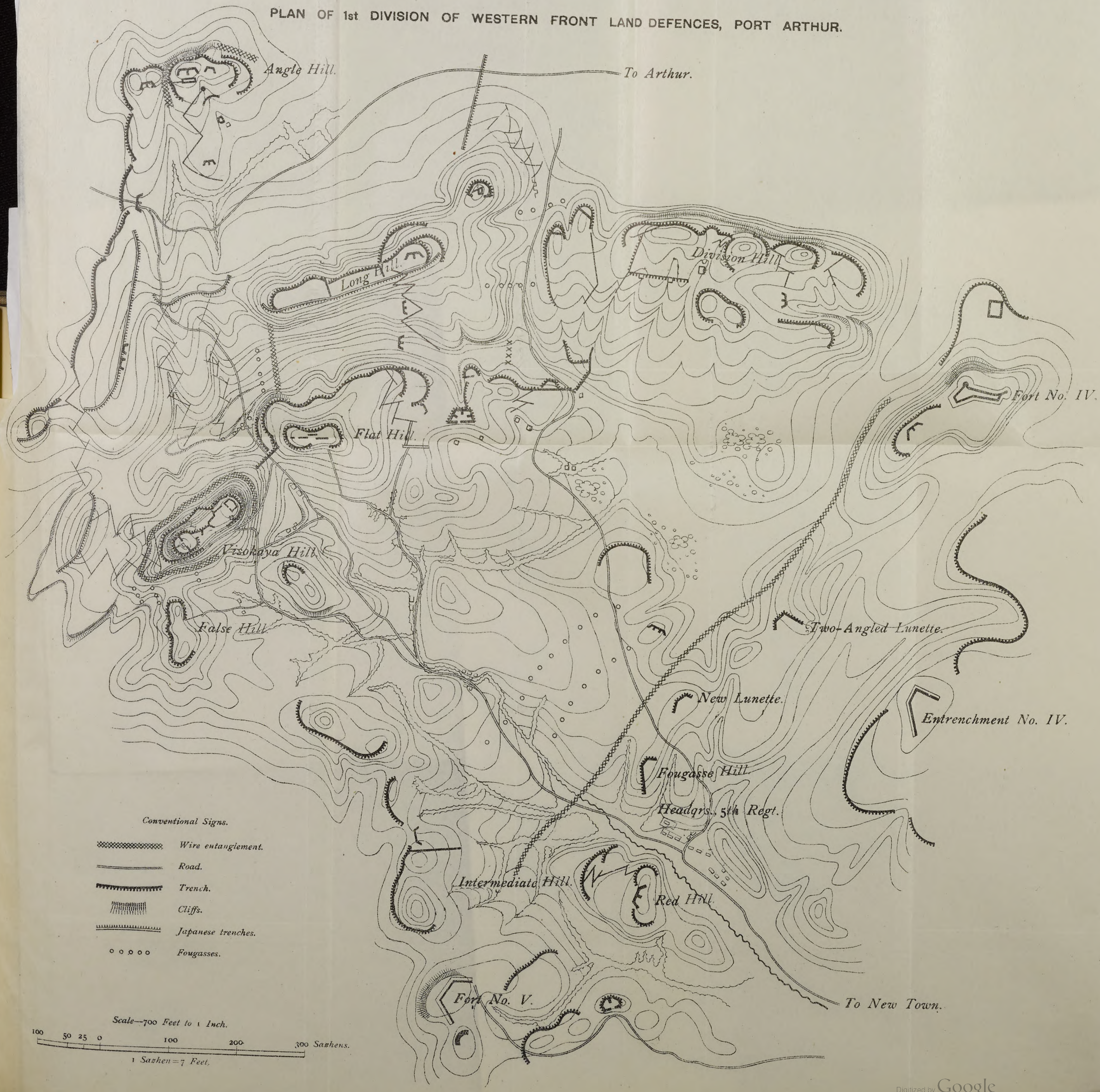
PLAN OF 1st DIVISION OF WESTERN FRONT LAND DEFENCES, PORT ARTHUR.



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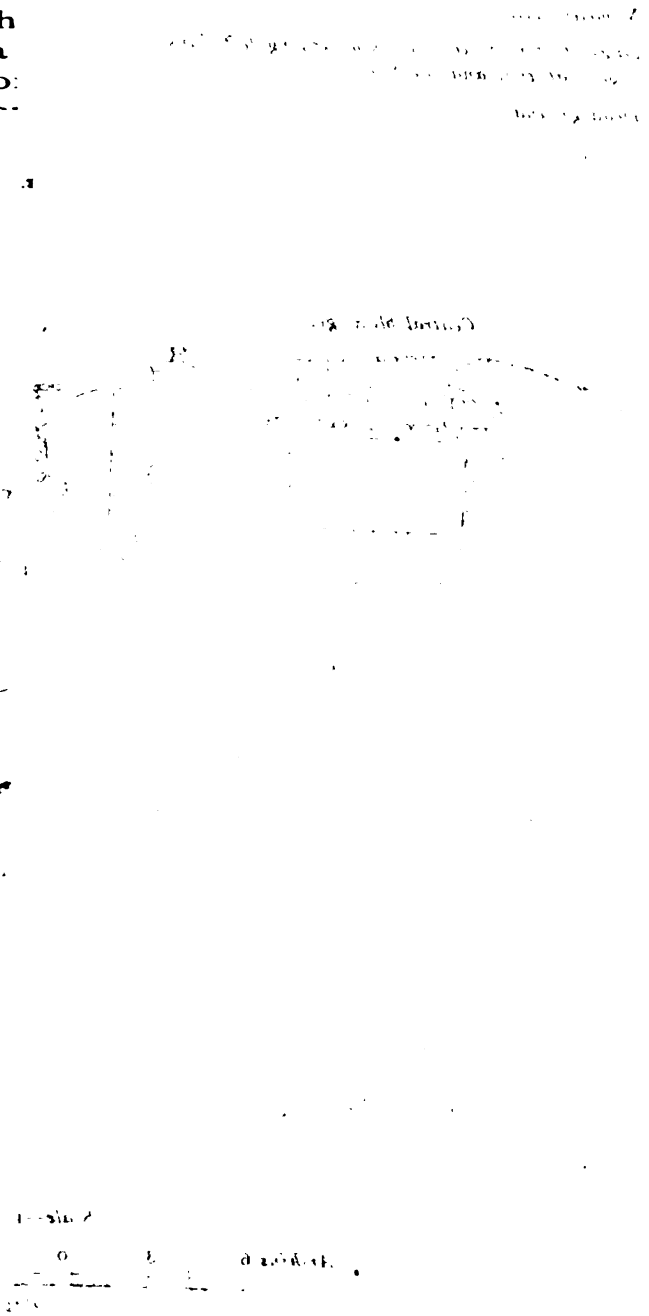

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NOTICES OF MAGAZINES.

MITTEILUNGEN ÜBER GEGENSTÄNDE DES ARTILLERIE-UND GENIEWESENS.

DIRIGIBLE BALLOONS AND AEROPLANES.—In view of the recent aviation week held at Rheims, the following notice, in the May number of this journal, on the military uses of dirigible balloons and aeroplanes, is of interest. The article divides airships into two classes :—

(1). Those lighter than air.
(2). Those heavier than air.

The first class—dirigible balloons—provide a large and prominent target for the artillery, have a mean velocity of 50 kilometres per hour (which is much less when they are travelling against the wind), and thus remain from 3 to 10 minutes within effective range of the guns. In this time an 8-gun battery can fire 800 shots, and a company of infantry about 30 volleys. A single well-directed volley or direct hit from a shell is sufficient to bring the balloon to the ground. Dirigible balloons also need costly sheds and workshops at fixed points on the line of march. Landing, even in a light wind, is no easy operation with a large balloon, and when accomplished, the balloon has to be instantly emptied, unless there is an appropriate shed to house it in. Whereas dirigible balloons seem to have attained the highest degree of perfection, aeroplanes have still vast possibilities open to them. The maximum velocity hitherto attained is 30 kilometres per hour,* but there is no reason to believe that this will remain the limit of speed ; in fact, in view of the progress made in recent years, the statement that an aeroplane bears the same relation to a dirigible balloon as a motor car to a traction engine seems by no means an exaggeration. Thus, from a military point of view, aeroplanes are preferable to dirigible balloons for the following reasons :—

(*a*). Aeroplanes have already a greater velocity than dirigibles, and appear likely to attain still greater speed.
(*b*). They can reasonably be expected to fly at greater heights than balloons, although at present such is not the case.
(*c*). They provide a far smaller target.
(*d*). In an aeroplane, only the motor and crew (one or two men) are really vulnerable, for small injuries to the planes do not affect the flight. In balloons, on the other hand, every shot which hits the gas-bag involves a loss in lifting power, and any kindling of the gases means destruction.

* At Rheims a speed of 74·318 kilometres was attained by M. Blériot.

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(*e*). The cost of aeroplanes is much less than that of dirigibles, especially if the necessity of sheds and workshops for the latter are taken into account.

(*f*). An aeroplane can rise from any free space without external assistance, whereas—especially in windy weather—a whole army of men is required to hold down a balloon.

(*g*). An aeroplane is light, and can be easily transported.

As regards the strategical uses of aeroplanes, their first object will be to reconnoitre the country in front of the army, with a view to discovering the points of concentration of the enemy. This reconnaissance, which is entirely different from that of the cavalry, will extend as far as 100 kilometres from the army, and must be carried out in one day. It will need two persons, one for the tactical work and the other for driving the aeroplane. Arrangements must also be made to automatically photograph the ground passed over. Each aeroplane can reconnoitre a strip of land 30 kilometres broad.

Tactically, aeroplanes will be used to find out the enemy's flanks, the position of his reserves and concealed batteries; to assist the artillery by observing their fire; and to carry messages either to other forces or to besieged towns. In fortress warfare they can be used at night to explore ground lit up by searchlights, their extreme speed making it easy for them to avoid discovery by the hostile lights.

As regards the offensive, aeroplanes are as yet powerless, the main difficulties being that explosives cannot be dropped from them with any accuracy, and that the weight of the charges required to really damage heavily armoured forts is greater than an aeroplane can carry.

THE RESULTS OF AERIAL NAVIGATION.—On the 23rd December, 1908, Major-General Kowanjko, commandant of the Russian airship park, gave a lecture at St. Petersburg on the results hitherto attained in aerial navigation and their application to military purposes. The three questions to be answered with regard to the latter part of the subject were:—

(*a*). Which of the existing flying machines has given the most satisfactory results?

(*b*). How must aerial navigation be organized, and what are its objects?

(*c*). What measures must the State take not to remain behind other countries in this new means of travelling?

To these the General added a fourth question: "What is required of an airship to make it suitable for war purposes?"

Military airships can be divided into five classes:—

(1). Fortress airships.
(2). Field airships.
(3). Siege airships.
(4). Coast airships.
(5). Airships for landing troops.

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These five classes can further be placed into categories :—

(1). Airships for the attack, *i.e.*, provided with explosives.
(2). Reconnoitring or signal balloons.

The fortress airship for purposes of reconnaissance must be able to rise to a height of at least 2,000 metres, and remain at least three hours at that altitude. Its speed must be from 54 to 65 kilometres per hour, and the time it can remain in the air 12 hours, needing a capacity of 8,000 cubic metres. Sheds and workshops must exist in its sphere of activity, and the meteorological conditions of the locality must be well known. The fortress balloon for offensive purposes must be able to carry explosives in large quantities for the destruction of objects beyond the range of the guns of the fortress. Field balloons are primarily required for reconnaissance, and must also be easily transportable. The non-rigid (*nicht starre*) balloons are especially suitable for this purpose. Siege balloons are similar in their requirements to fortress balloons, but must be more mobile. Coast balloons are balloons for attacking ships, destroying mine-fields, and preventing blockades; their *rôle* is an offensive one.

Landing balloons—a German invention—would be balloons about five times as big as the Zeppelin airship, and capable of carrying 100 to 300 men. It is interesting to note that, size for size, their cost is $\frac{1}{13}$ of that of a modern warship.

Flying machines of the heavier-than-air type can be divided into three classes :—

(*a*). Ortopters—which imitate the flight of birds.
(*b*). Heliopters—propelled by a screw.
(*c*). Aeroplanes—with fixed planes—which are propelled by means of motor-driven screws.

The construction of aeroplanes is making such rapid progress that it would be unwise for any army to disregard this new factor in the art of war, and, moreover, the training of a certain number of expert aviators is made essential, as "driving" an aeroplane is an art which it takes much practice to acquire.

GERMANY.—To encourage firms to manufacture heavy tractors of 30-H.P. and more, suitable for military purposes, the German Government has voted 1,000,000 marks to be spent in subsidizing firms who make use of such tractors. They are not to be sold to foreigners.—The number of infantry machine-gun detachments has been increased from 17 to 50. A machine-gun detachment is commanded by a subaltern, and consists of three sections of two guns, each section being commanded by a lieutenant. Thus each battalion has two guns at its disposal, as opposed to four mitrailleuses per three battalions, as in the French Army.—Practice against captive balloons is to be carried out again this year in the Gulf of Dantzig. Guns on special mountings will be used, as the past year's practice with howitzers was unsatisfactory. An anti-balloon gun must command all altitudes from which a balloon can make observations or throw explosives.

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FRANCE.—According to the *Revue de l'Armée Belge*, the firm Creusot has placed before the French War Office a shield of nickel steel, 3·8 millimetres thick, 30 millimetres high, and 35 centimetres broad, whose weight is 3·3 kilogrammes. The increase in weight involved by carrying this shield would, in the case of the infantry, be counterbalanced by not carrying a second pair of shoes and certain articles of clothing not absolutely essential, and also by the use of a lighter type of haversack. The price of such a shield is 7 francs 20 cents.

A. H. SCOTT.

REVUE MILITAIRE DES ARMÉES ÉTRANGÈRES.

May, 1909.

A TERRITORIAL FORCE (MONTENEGRO).—Since the proclamation of the constitution in 1906, a methodical system of organization and administration for the army has been thought out, and the results are incorporated in the Recruiting Act of 1908. The Montenegrin Army, like the Swiss, remains, as before, a national militia force, but now possesses a legislative basis.

Every Montenegrin between the ages of 17 and 60 must serve as follows:—

Recruits' Classes (18 to 19 years of age), which consist of two trainings, each lasting four weeks.
Regular Army (1st class), 20 to 44.
Regular Army (2nd class), 45 to 50.
Reserve, 51 to 60.

The regulars have each year to attend manœuvres (15 days) and also the occasional parades ordered by the O.C.'s of their company, battalion, brigade, and division.

The men who desire to qualify for the rank of N.C.O.'s are chosen by their battalion commanders from soldiers of not less than three years' service, and undergo a month's course, have charge of a squad of recruits for eight weeks, and then attain, at about the age of 23, the rank of *desetchar* (commander of ten, or lance-corporal). The same routine is followed to obtain the rank of corporal, which is reached when 27 to 28 years old. At about 31 years of age the corporal can become a second lieutenant, after a five months' course; at 34, he can become a lieutenant; at 38, a captain; at 44, a major; at 52, a major-general; and at 62, a general. The ranks of colonel and lieutenant-colonel are unknown.

Promotion examinations, both theoretical and practical, have to be passed for promotion to all ranks up to major. Besides the Regular Army, there exists the "Special Service," composed of officers *de carrière*. They are chosen from boys who have either had a secondary education, or have undergone a course in some military college in Montenegro

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or abroad. In the latter case the candidates have to pass an examination in the organization of the Montenegrin Army. The rates of promotion are as in the Regular Army, but the first commission is obtained at the earlier age of 22. After three years' service, officers have to pass an examination similar to that for Staff College; if they fail twice, they keep their rank in the Regular Army, but leave the "Special Service"; if they pass, they are sent to study in some foreign Staff College.

Officers of the "Special Service" get 30 days leave per annum, exclusive of short leaves of 3 days.

AUSTRIA.—Successful trials have been made with 100-H.P. 6-cylinder Daimler motor cars, to drag 24-cm. siege howitzers. The speed attained was 15 kilometres per hour and the car can drag the howitzer across fairly rough ground.

GERMANY. — The War Office at present possesses the following airships:—

Three Gross (half-rigid system).
Parseval No. 2 (non-rigid system).
Zeppelin No. 1 (rigid system).

These are to be distributed as follows:—

A dirigible of either system will be stationed at both Metz and Cologne. This will be possible in three or four months, when Parseval No. 3 and Zeppelins Nos. 2 and 3 have been bought.

Zeppelin No. 1 remains at Friederichshafen, and is to be used for instructional purposes by the "Luftschiffee Batallion."

A new shed is being built near Griesheim by the pioneers of the VIIIth Corps, garrisoned at Maintz.

In the June number of the *Revue* it is stated that as the result of several trials the War Office has decided to place a certain number of search-lights on motor cars, and, it is believed, to make use of them in the coming manœuvres. The present model has an illuminating power of 25,000-C.P., and is driven by a 10-H.P. engine.

ITALY.—120 machine guns have been issued by the War Office for use by the infantry, cavalry, and Alpine troops of the Ist, IInd, and IIIrd Corps.

June, 1909.

THE TURKISH ARMY IN 1909.—The revolution on the 23rd July, 1908, has not only already brought about great changes in the organization of the Ottoman Army, but has led to other changes also being considered. It is proposed therefore to give the following details of the army as it actually is at present, so that any new transformations may be more readily understood.

(1). *High Commands and Central Administration.*—The Sultan is still the head of the military forces, but now exercises his power through the War Minister, and not personally as heretofore.

The central administration originally consisted of the War Minister and the Grand Master of Ordnance. Since the end of 1908 the Grand

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Master of Ordnance is placed under the War Minister and has the title of *nazir* (grand director).

(2). *Population, Strength of the Army, and Recruiting Laws.*—The Ottoman Empire has a population of 24,000,000 souls. Several of these are either Christians, Albanians, inhabitants of Constantinople, Arabs, or Anatolians, and as such are exempt from military service. 11,000,000 to 13,000,000 Mussulmans are left, who have to provide an army with a peace strength of 267,000 men. Certain classes, *e.g.*, persons holding functions in the Sultan's court, educated youths, and theological students, are further exempted, but steps are being taken to revoke the exemption of theologians, as in many villages the inhabitants study theology to avoid military service. Attempts are also being made to raise extra troops by the formation of Albanian, Christian, and other irregular battalions, but have as yet met with little success.

In 1908 the strength of the army was reduced from 386 to 357 battalions.

The duration of service is three years, but may be prolonged should the national political situation demand it.

The population has to serve as under:—

Class A.—Men who serve three years in the standing army:—
- Between 21 and 23 in the Nizam (Regular Army).
- Between 24 and 29 in the Ikhiat (Class A Reserve).
- Between 30 and 38 in the 1st Class Redif (or Reserve).
- Between 39 and 40 in the Mustafiz or Territorial Militia, which has no permanent organization.

Class B.—Exempted men:—
- Between 21 and 38 in the 2nd Class Redif (Reserve), *i.e.*, six to nine months' actual service.
- Between 39 and 40 in the Mustafiz.

The men of the Redif are called out for a month's training every two years, but may be kept six months should the political situation demand their retention.

(3). *The Officers.*—The officers are drawn from two sources:—

(*a*). Mektebli, from military schools.
(*b*). Alaili, from the non-commissioned ranks.

The latter only undergo practical promotion examinations, and consequently are often very illiterate.

The Mektebli are educated:—

(*a*). For four years in one of 32 elementary schools under military direction.
(*b*). In military colleges, like the German Kadetten Schule, on leaving which they enter either:—
  (1). The Imperial School of Military Sciences at Pancaldi (Constantinople) for cavalry or infantry—a two years' course, or
  (2). The Military School for Artillery and Engineers at Constantinople for a three years' course.

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The top competitors on passing out receive a further three years' course, and join the general staff, or the headquarter staffs of the artillery or engineers.

The candidates are all chosen young, brought up in a very modern way by European professors, and thus form a body of officers ready to carry out new ideas. There is practically no supply of reserve officers.

The N.C.O.'s are often professionally good men, but are extremely illiterate.

4. *Organization.*—Turkey is divided into seven military districts (*Ordous* or *Army Corps*) and two independent divisions (Tripoli and Hedjaz).

1 ordou = 2 to 4 regular (nizam) divisions, 1 cavalry division, and an artillery division of as many brigades as there are infantry divisions.

Six of these districts are subdivided into four redif (reserve) districts. These reserve troops, being composed of peasants used to handling arms, may be taken as of equal value as the nizam troops. Three of the ordous are in Europe, at Constantinople, Adrianople, and Salonika, the remaining four in Asia Minor. The redif divisions have no artillery.

5. *Engineers.*—The engineers are made up of—

(*a*). Fortress troops in Europe = 3 battalions pioneers, 1 battalion miners; and in Asia, 2 pioneer companies at Damascus and Baghdad.

(*b*). Field troops—1 battalion to each of the first four ordous. Each battalion = 3 pioneer companies, 1 company miners, 1 telegraph company. Also 1 company to the Hedjaz division and 1 battalion (4 companies) to the Tripoli division.

(*c*). 3 railway battalions.

(*d*). The bridging material at Constantinople = 15 trains of 2 trestles and 6 pontoons each.

(*e*). In war time 11 4-company redif battalions are organized.

6. *Foot Artillery* of 154 companies.

7. *Transport and Supply* troops, consisting of 7 battalions of 3 companies each.

8. *Gendarmerie.*—Composed of 33 regiments of 3 to 6 battalions, each battalion being made up of 4 companies and 1 squadron. Total, 100,000 men and 18,000 horses. The gendarmerie is to be reorganized, and the foreign officers allotted as follows:—French to Macedonia; English to Syria; Italians to Anatolia.

9. *Armaments.*—The infantry are armed with 1890 Mausers, calibre 7·65 millimetres. In the artillery the 75-millimetre Q.F. Krupp gun is going to supersede the 87-millimetre Krupp on a non-recoiling mounting.

The strength of the field artillery is:—

30 regiments = 60 battalions	= 180 batteries.
9 battalions mountain artillery	= 27 ,,
6 battalions horse artillery (78·5 Krupp) ...	= 18 ,,
2 howitzer regiments (12-cm. Krupp) ...	= 12 ,,
The artillery of the VIth and VIIth Ordous and the Tripoli division	= 34 ,,
Total	271 batteries.

The cavalry is armed with a sword and the 7·65 Mauser carbine.

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10. *Actual State of the Army.*—Since the revolution the army has presented a scene of busy activity. A new infantry training manual, like that of the German Army, has been published, long distance rides have been undertaken by the cavalry, and the artillery have at last carried out practice with live shell. Manœuvres have been carried out, mainly under the direction of junior officers, who have undergone courses in foreign schools. Finally, a daily military paper, *Asker*, has been founded.

A. H. SCOTT.

RIVISTA DI ARTIGLIERIA E GENIO.

May, 1909.

AUTOMOBILES OF VARIOUS COUNTRIES.—In the organization of armies no invention can be overlooked. Not only should industrial inventions be accepted, but others should be sought for. Much has been done by the science of metallurgy which is especially due to the requirements of the fleets and of modern armies, which are its most important clients. Setting aside the moral factor—always of the greatest importance—it may be retained as a maxim that the nation which will be best adapted for sustaining a war will be that one in which the military institutions have been kept on a level with the latest industrial successes.

One of the more recent of these successes is the automobile, which after a certain period of trial is now largely employed in several armies, and is capable of rendering immense service in a campaign.

It may perhaps not be out of place to give a short account of what has been done by other nations, as well as Italy, towards applying automobilism for military use; and by doing so we may be able to regulate the production of automobiles, and to organize our automobile services in a manner that will enable us to confront any eventualities.

Belgium.—Although provided with good roads, automobile manufactories, and enthusiastic automobilists, Belgium has not made great advance in military automobilism. It is however forming an automobile *personnel* for reconnaissance and inspections, and experiments are being carried out with automobile wagons for the transport of stores and ammunition. The Government of the Congo has constructed at Brussels an automobile of 30-H.P., to carry a weight of 1,000 to 1,500 kilogrammes, with a velocity of 15 to 20 kilometres per hour. Wood or petrol is used. This vehicle would do the work of 400 p orters.

Bulgaria.—The War Office has organized a section of troops of communication, and has sent a Commission to Vienna to examine the organization of the automobile service of the Austro-Hungarian army. This Commission has visited several automobile factories and has assisted at several experiments.

Denmark.—The proposals of Dr. Westenholz have been adopted for the creation of a corps of automobile volunteers. He has placed at the disposal of the State 3 automobiles, 80 motor cycles, and 80 automatic rifles, with 3,000 cartridges per rifle. Each motor cyclist will carry

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an automatic rifle and a first instalment of 800 cartridges; the remainder of the ammunition will be carried in the automobiles. The corps will be organized, and will receive military instruction under the command of a captain. The volunteers will perform 14 days' service each year, during the period of the manœuvres.

France.—No corps of automobile volunteers has yet been formed in France, but there are groups of automobilists organized on a military basis. At Paris there is the *Société militaire d'automobilistes*, which proposes to give to its members a sufficient military instruction, with a view to their becoming not only good individual chaffeurs, but also good leaders of automobile convoys. In the Paris district there is also the *Association amicale des automobiles militaires*, which has for its scope the grouping of automobile volunteers, and of proposing to the military authorities conductors who may be useful under all conditions, will be well clothed, and imbued with a sense of responsibility in event of mobilization. The military journals in France insist on the need of a real corps of volunteer automobilists.

At the end of 1897 the Minister of War instituted a Commission of officers to enquire into and study the uses of the automobile for military service. This Commission has up to the present followed all the trials made with the automobiles. In 1900 the War Minister, owing to the favourable reports furnished by the Commission, acquired two trains—Scott—which were placed on service between Versailles and Vincennes for the transport of artillery; one Panhard-Levassor and one Peugeot automobile were also acquired for the transport of *personnel*.

At the great manœuvres of 1900 service automobiles were employed for the first time. The trials gave good results, so that the employment of automobiles at the great manœuvres became the subject of special regulations.

At the manœuvres in 1901 light wagons and autocars were used in great numbers, and in 1903 the Renard train made its appearance.

At the siege exercises at Langres in 1906 10 automobile wagons were used for carrying water from a distance of 40 kilometres.

The trials at the great manœuvres of 1907 were of great importance. In those which took place in the south-east of France 40 automobiles (supplied by the French Automobile Club) were used for victualling the 18th Army Corps. Bordeaux was selected as a victualling centre, and the cars had to traverse from 100 to 140 kilometres daily to supply the regiments.

At the manœuvres of the 7th Army Corps at Besançon the victualling was supplied by an automobile car of 75-H.P. and three wagons in tow. The length of the train was 225 metres and had a working capacity of 10 tons. These trains made daily journeys of about 90 kilometres, the greatest being 130 kilometres. They transported altogether about 9,000 tons of stores. This experience shows that road trains can be used with great advantage on a campaign.

At the great manœuvres in 1908 between Tours and Bourges the provisions for the troops were transported entirely by automobiles. Endeavours were made to arrive at a truly practical type of vehicle,

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the ideal being a unique type in which all the cars were identical in construction.

The average velocity should be 12 kilometres for the automobile cars (or autocars) and 9 kilometres for the trains.

A complete set of regulations for the census and for the requisitioning of the automobiles has been approved by the House of Deputies. The War Minister has notified that from 1910 on, he will ask from Parliament an important sum of money, to be assigned as prizes for the automobiles best adapted for war service. Under the date of the 18th March, 1908, the *Bulletin Officiel* published "Provisional Instruction for the Employment of Automobiles in the Army," a notice of which was given in this Review (in 1908, Vol. II., p. 293).

Italy.—Italy, which possesses relatively few horses, has greater opportunities than many other nations of employing automobiles as a means of transport for the army. Since the end of 1873, road locomotives have been used both in the army and for industrial purposes. In successive years a certain number of road locomotives were acquired (in England) for military purposes, and were usefully employed on the construction of fortifications and on the transport of stores. These locomotives were rather slow—5 kilometres in the hour—but strong, and were used in building the arsenal at Spezia, and for the armament of all the fortifications of this military post. In late years the road locomotives have been abandoned and automobiles with benzine have taken their places.

In the summer of 1904, an experiment was made with 29 carriages which, setting out from Brescia, were charged with the duty of making journeys of 200 kilometres in 24 hours. A similar trial was carried out in the winter season in February, 1905. These trials, made under different conditions of temperature and strain, resulted in the acquisition of the normal type of automobiles used by the army in the following years.

At the manœuvres at Novara, in 1905, and 1907, and Liguria, in 1907, the cars were used for the transport of the officers and the wagons for transport of stores and provisions.

By a ministerial decree of 18th July, 1906, an automobile section of the railway brigade was formed, and the training of officers of the several arms in courses of automobilism was entrusted to it.

EDWARD T. THACKERAY.

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RECENT PUBLICATIONS OF MILITARY INTEREST.

JULY, 1909.

(*Published Quarterly*).

THE following extracts from the list compiled by the General Staff, War Office, are published in the *R.E. Journal* by permission of the Army Council.

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PART II.

SECTION I.

HISTORICAL.

THE BRITISH EMPIRE, ITS PAST, ITS PRESENT, AND ITS FUTURE. Edited by A. F. Pollard, M.A. 864 pp. 8vo. London, 1909. The League of the Empire. Caxton Hall. 5s.

This exhaustive account of the British Empire owes its origin to the generosity of Mr. Louis Spitzel and the enthusiasm of Mr. Thomas Henry Monk, though, unfortunately, neither lived to see the result of their practical interest in the Empire. The work made possible by their efforts however was entrusted to the History Section of the League of the Empire, with Professor Bury as its chairman. The object of the volume is primarily educational, and the secondary object is to make further provision for education in the Empire.

The work is divided into three sections (or books), and begins with a description of the physical features of the British Isles and a brief outline of English History from the year B.C. 55 up to the present time. It also deals with the founding of the British Colonies, commercial expansion, and other political and social problems. About one-third of the contents of the book is the result of the co-operation of men actually responsible for the government of the Empire in all quarters of the globe.

Book 2 deals with the self-governing States; their expansion, politics, natural resources, trade, etc.

Book 3 treats of the Empire of India, Crown Colonies, and Dependencies.

Accounts of the wars in Canada, the American War of Independence, New Zealand wars, the several conflicts in South Africa, including the war 1899—1902, and wars in India are included in this volume, together with the events leading up to them and the results which followed.

The chapter on "Downing Street and the Colonies" (XVI.) and the concluding chapter on "The Future Organization of the Empire" are of interest to all students of the Imperial problem.

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THE CHANCELLORSVILLE CAMPAIGN. By Charles Richardson. 124 pp. 8vo. New York and Washington, 1907. The Neale Publishing Company. 4s.

The author, who is a Southerner, confines himself, as the title page "Fredericksburg to Salem Church" indicates, to an account of the part played by Sedgwick in the above campaign. The sketch which he gives of the Federal general's operations is very slight. It takes the shape of a narrative without criticism or comment, maps or plans, set forth in somewhat high-flown language, and consequently fails to throw any light upon the controversies which have arisen in regard to the conduct both of Sedgwick and Early.

GERMAN OFFICIAL ACCOUNT OF THE RUSSO-JAPANESE WAR (WA-FAN-GOU). Authorized translation by K. von Donat. 256 pp., with 4 appendices, including 5 photographs; 11 maps in pocket. 8vo. London, 1908. Hugh Rees. 10s. 6d. (For Yalu volume see p. 14 of No. 8).

This is a continuation of the history prepared by the German Great General Staff. The first portion dealt with Port Arthur, and of this no translation has yet been published. The second was an account of the events leading up to the war, and the operations by land and sea up to the Ya-lu inclusive. The present volume is the third instalment, and deals with the operations after the Ya-lu and up to the evening of the 28th August, 1904, immediately preceding the Battle of Liao-yang.

The work has the same defects as the translation of the second instalment, in that the names are spelt according to the German method, so that it is only by comparing dates that some of the places can be identified, and the English is at times a little hard to understand. The details are however worked out in a most painstaking manner, and the book contains a quantity of useful information.

It is divided into six chapters, of which the first opens with a description of the situation in the south-western theatre towards the end of May, 1904. The Battle of Nan-shan was described in the first part of the history, and only the briefest of references is here made to it; the earliest general action considered is that of the 2nd Japanese Army at Tê-li-ssŭ (Wa-fang-kou). The second chapter is a continuation of the first, and deals with the operations subsequent to Tê-li-ssŭ up to the beginning of August, 1904. General Kuropatkin is described as nervous lest his "southern detachment" at Kai-p'ing might be cut off, and as having lost heart after the reverse of Tê-li-ssŭ. The chapter includes an account of the Battle of Ta-shih-ch'iao and of the arrival of the 4th Japanese Army, which came into position on the right of the second, ending with the occupation of Hai-ch'êng by the Japanese.

In Chapter III. the scene is shifted to the eastern theatre, and the operations are described from the time the 1st Japanese Army left Fêng-huang-ch'êng until the beginning of August, 1904. It is stated that Kuropatkin, being anxious about his left flank, sent the 10th Army Corps to check any movement in that direction, and that this corps sacrificed its initiative for the sake of having an entrenched position on to which it could fall back.

Chapter IV. contains a survey of the situation immediately before the operations leading up to the Battle of Liao-yang. On the whole it is disappointing, but some interesting examples are given of the Russian ignorance as to the forces to which they were opposed. The total strength of the Japanese in Manchuria at this time, *i.e.*, the 1st, 2nd, and 4th Armies, is placed at 125,000, while the number of Russians opposed to them is estimated at 185,000, of whom perhaps 140,000 were combatants. The Russians, moreover, received reinforcements during the fighting, whereas the Japanese grew steadily weaker owing to their heavy losses.

Chapter V. describes the operations resulting from the advance of the 1st Japanese Army on Liao-yang, and the fighting of the 26th to 28th August, while Chapter VI. deals with the 2nd and 4th Armies for the corresponding period, and closes with a general review of the situation on the evening of the 28th August, 1904.

The most interesting portion of the book is the chapter of comments with which it concludes. Although consisting of barely 10 pages, it is full of trenchant criticism from

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beginning to end. Attention is drawn to the peculiar effect which the geographical features of the country had upon the Russian strategy, by neutralizing to a large extent the advantage which they possessed in acting on interior lines, but adverse comment is made on the lack of decision and initiative displayed by the Russian commanders, and on their habit of relying on entrenched positions. The slowness of the Japanese advance is attributed to the necessity for making sure of everything which they gained, and of guaranteeing themselves against any reverse, however slight, lest difficulties should arise when they required their next foreign loan.

The Appendices show the organization of the forces on both sides.

THE RUSSIAN ARMY AND THE JAPANESE WAR. By General Kuropatkin. Translated by Capt. A. B. Lindsay, 2nd Gurkha Rifles, and edited by Major E. D. Swinton, D.S.O., R.E. In two volumes, with maps, illustrations, and index. Vol. I., 309 pp.; Vol. II., 335 pp. 8vo. London 1909. Murray. 28s.

The original work consisted of four volumes, the first three of which dealt with the fighting round Liao-yang, on the Sha Ho, and at Mukden.

Capt. Lindsay's translation embraces only the fourth and a small portion of the third volumes.

General Kuropatkin commenced his book in Manchuria while superintending the demobilization of the Russian forces after the war, and completed it at his country seat in Russia. Its publication in Russia was immediately stopped.

The work at present under review, being well translated and carefully edited, forms a readable and instructive publication, providing much food for thought, as well as useful information for the student of Russian military organization.

As the translator aptly remarks in his preface, it is no mere *apologia*, but a protest that the war, as far as Russia was concerned, was not fought to a finish.

The following is a brief summary of the contents :—

Volume I. Author's introduction.—Sources from which the material for the first three volumes were drawn. Baneful influence of the Press. The work done by the Ministry of War during the period 1898—1904.

Chapter I.—The problems with which the Russian War Department was confronted during the past two centuries. Russia's struggle to reach the Baltic and Black Seas. The problems of Poland and Finland. Causes of the failure in the Crimea, 1854-55. Defective organization exposed by the Russo-Turkish War, 1877-78.

Chapter II.—The strategical suitability of Russia's European and Asiatic frontiers. Possible results of a war with Germany or Austria.

No advantage to be gained by territorial acquisition in Persia. The possession of India would be an insupportable burden for Russia. Necessity for strengthening Russia's western frontier in preference to aggressive enterprise elsewhere.

Chapter III.—The expansion of the Russian Army in the 18th and 19th centuries. The growth of neighbouring armies. Russia's isolation in 1878. Afghanistan a hostile buffer State. The inferiority of Russian strategic railways. The magnitude of the problem of the defence of the Russian Empire.

Chapter IV.—Russia's military policy in the 20th century. No need to increase her territory. Great danger on the western frontier, owing to the perfect state of German and Austrian preparations. Russia, being essentially a land Power, ought not to spend large sums on a navy.

Chapter V.—The task which confronted the War Minister previous to 1904. Inadequacy of the sums voted for improving the army.

The strengthening of Russia's position in the Far East. Vladivostok and Port Arthur. The Siberian Railway. New Q.F. field guns.

Chapter VI.—Kuropatkin's efforts, as War Minister, to avert hostilities with Japan. Bezobrazov and the Royal Timber Company.

Chapter VII.—Causes of the success of the Japanese. Their patriotism and high *moral*. Low estimate of their strength formed by the Russian staff.

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Chapter VIII.—Reasons for the failure of the Russians. Insignificant part played by the fleet. Inadequate carrying capacity of the Siberian Railway. Delay in mobilizing reinforcements. Anxiety for her western frontier and internal disorders prevented Russia from sending her best troops to the Far East. The long railway journey was detrimental to efficiency and discipline. Lack of military spirit among the older reservists. Depletion of the combatant ranks. Shortage of officers. Defective technical equipment. Premature declaration of peace.

Volume II. Chapters IX. and X.—Reasons for Russian failure (continued) :—

Want of uniformity in training of troops, especially in the Kiev Military District, under General Dragomirov. Faulty staff work. Neglect of intercommunication. Insufficient cavalry reconnaissance. Lack of co-operation. Employment of dense formations in the attack. Waste of ammunition. Neglect of the spade. The series of instructions issued to the troops by Kuropatkin during 1904 are given. They are full of elementary platitudes, and contain frequent allusions to bad leading on the part of officers and skulking on the part of the rank and file. Ignorance and general inefficiency of the reservists. Strategical error in not concentrating at Harbin until the arrival of reinforcements. Evil influence of seditious propaganda among the troops. The Russian troops were unfamiliar with mountain warfare. Units were below strength owing to the large number of men employed on non-combatant duties, and various pretexts found for quitting the ranks. Drafts arrived too late.

Strained relations between the Commander-in-Chief and corps commanders. Disregard and wilful contravention of orders. General Grippenberg specially censured in this respect.

The defects of the officers are enumerated. Higher commanders showed lack of initiative and ignorance of tactics. Regimental officers unable to read maps. Regular officers were, as a rule, brave but ignorant. Ensigns of the reserve proved very unsatisfactory and lacked military instinct. Those promoted from the ranks for distinguished service were excellent.

General staff officers did good work, but were not sufficiently in touch with the troops.

As regards the rank and file, those serving with the colours were thoroughly reliable, but many of the reservists, especially second category men from large towns, were difficult to handle.

The war was unpopular. Lamentable indifference of the civil population. Thousands of idle students unwilling to enlist. Hostility of the social revolutionaries.

Kuropatkin's farewell address to the officers of the 1st Manchurian Army is given at length.

Chapter XI.—Measures suggested for improving the army.

The principal reforms advocated are* :—

(1). The amelioration of the material position of the officers.
(2). Inducements to N.C.O.'s to extend their service.
(3). Means for keeping reservists in touch with the army.
(4). Relieving the private soldier from non-military duties.
(5). Increasing the proportion of sappers in a division.
(6). Reducing the proportion of guns to rifles in a division to 3 per 1,000.
(7). The formation of depôt battalions for each regiment on mobilization.

As regards higher organization, the author advocates having three infantry divisions in an army corps, each division consisting of two infantry brigades, a regiment of artillery (four batteries of 12 guns each), a sapper battalion, a telegraph company, and two squadrons of cavalry, besides transport company, parks, hospitals, bakeries, etc.

For the composition of a cavalry division he recommends three cavalry brigades and a horse artillery battery of 12 guns. Two batteries of howitzers (12 howitzers to each battery) should be allotted to each army corps as corps artillery.

The failure of the cavalry in the war was due to bad leading. The junior officers were, as a rule, good, the field officers moderate, and the generals, with few exceptions, bad.

* Most of the suggestions have since been adopted.—*General Staff, W. O.*

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Chapter XII.—Recapitulation of the causes of the failure of the Russians. Improvements made during the war to the Siberian Railway. Carrying capacity raised from 2 to 12 pairs of military trains in 24 hours. The Russian Army had reached a strength of 1,000,000 men when peace was declared, while the Japanese were then at the end of their resources.

Chapter XIII.—Introduction and conclusion to Volume III. A recapitulation. Difference of opinion between Kuropatkin and Viceroy Alexeev as to the strength of the garrison required for Port Arthur.

Disposition of the Russian troops in the Far East in March, 1904. Premature engagement with the enemy by General Zasulich on the Ya-lu in direct contravention of Kuropatkin's orders. Zasulich's excuse that he thought he could defeat the enemy. Kuropatkin advocated concentration of forces in Manchuria, and discouraged the relief of Port Arthur.

Account of the fighting at Liao-yang and on the Sha Ho. Mishchenko's raid on Ying-k'ou. Battle of Mukden. Causes of the Russian defeat. Kuropatkin blames himself.

Appendices.—I. The Royal Timber Company. II. The breakdown of the Russian unit organization and system of distribution.

NAPOLEON'S STAFF OFFICERS (Les états-majors de Napoléon). By General Derrécagaix. 650 pp., with 8 maps and plans. 8vo. Paris, 1906. Chapelot. 10s.

The author points out that, after the successive victories of Napoleon, the names of his great generals became household words, and all the successes were rightly attributed to them. Many of the triumphs however could not have been gained without such men as Berthier, Andréossy, Belliard, etc.

Belliard, Murat's chief of staff, was *par excellence* a cavalry staff officer, and possessed many of the qualities in which Murat was deficient.

As staff officer of cavalry, Belliard's record of campaigns comprises the wars of the Republic, campaign in Italy, the Tyrol, Egypt, Austerlitz, Prussia, Poland, Spain, Russia, Saxony, and the war of 1814. It was only in 1815, when Murat was no longer available, that the Emperor gave him command of a corps.

NAPOLEON'S MARSHALS. By R. P. Dunn-Pattison. 358 pp., with index. 8vo. London, 1909. Methuen. 12s. 6d.

The careers of the 26 marshals of the First Empire contained in this volume are of more interest as a study of their characters and of the character of the Emperor than from a historical point of view. The events in which they took part are but briefly outlined in so far as they affect the subject of the biography. The character sketches are well drawn and are interesting. Portraits of 19 of the marshals add to the attraction of the book.

THE RUSSIAN CONQUEST OF THE CAUCASUS. By John F. Baddeley. 518 pp., with 5 maps, 2 plans, and illustrations. London, 1908. Longmans, Green. 21s.

The Caucasus may be described as a mountain chain 650 miles long by about 100 miles broad. In the west, a forest region stretching down to the Black Sea, the Cherkess tribes waged desultory war against Russia from the end of the 18th century till 1864. In the east the inhabitants of the forests of Chechnia and of the mountain plateaus of Daghestan defended their country nearly as long and with a larger measure of temporary success. In the centre the local tribes never gave serious trouble, and so the Georgian road, the only line by which the Russians could move south to the help of their Georgian allies beyond the great range, remained in Russian hands, and the eastern theatre of war was sharply divided by a strip of territory, some 140 miles wide, from that in the west.

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This book gives an interesting connected account—the first complete account to appear in either Russia or England—of the operations in the eastern theatre, "the wars of the left wing," as they are called by Russian writers.

In 1801 Georgia was annexed by Russia. The following 28 years were occupied by wars against Persia and Turkey, and it was in 1830 that the Russians first seriously applied themselves to the subjugation of the hill tribes. In 1834 Shamil, as third *Imam*, placed himself at the head of the movement called Muridism, which, while originally purely religious, was developed for patriotic purposes to unite the tribes against the Russian invader.

Up till 1845 the Russians confined their operations to isolated expeditions, which produced no lasting impression. In 1845 Prince Vorontsov first initiated the policy of advancing the Russian lines slowly and steadily towards the centre of the disaffected district, and there stifling the revolt at its heart. This policy at length succeeded, and Shamil was surrounded and taken prisoner at Gunib on the 6th September, 1864.

The resistance of the mountain tribes of the Caucasus was the most formidable obstacle that Russia has yet met in her expansion towards the Middle East. Her subsequent advance through the level plains of Trans-Caspia to the northern frontier of Afghanistan has been accomplished with comparatively little loss.

The reader cannot fail to be struck by the remarkable resemblance of these mountain tribes to the Pathans on our own north-west frontier in India. Both are brave, proud, hospitable; both are alike in their fanaticism, passionate love of liberty, and in their harsh treatment of women. It is interesting to imagine, in the light of the difficulties in which Russia was involved in the Caucasus, what our experiences would be in India were it decided to advance the present administrative boundary up to the Durand line and bring the border tribes under our direct rule.

The description of the various engagements is interesting. In the northerly district of Chechnia the operations consisted of wood fighting. The Russian columns moved with patrols and scouts thrown out on all sides and camped at night in square formation, with infantry and artillery on the flanks and cavalry and transport in the centre. The Chechens constantly harassed the flank guards, but seldom succeeded in reaching the main column. They placed their main reliance on the beech woods of the country, and were eventually conquered more by the axe than by the sword. The *auls*, or villages, of Daghestan were built on sites where they could not be commanded from more elevated points within range of the guns then in use. They could be subdued only by storming, and, as the Murids fought to the last and the houses were arranged to enfilade one another, this storming was a formidable business.

POLITICAL.

PRINCE BÜLOW AND THE EMPEROR WILLIAM II. (Fürst Bülow und Kaiser Wilhelm II.). By Rudolf Martin. 287 pp. 12mo. Leipzig, 1909. Bruno Volger. 4s.

This book is a very severe criticism on the management of German politics by Prince von Bülow, especially as regards his conduct in the affair of the famous "interview" which appeared in the *Daily Telegraph* of November, 1908.

The author asserts that it was Mr. Harold Spender who compiled the "interview" in question, that the document was submitted by the Kaiser to Prince von Bülow for a report on its contents, and that the latter was guilty of grave negligence in failing to examine it. The interview, says Herr Martin, never really took place, but is a combination of alleged conversations of the Emperor in the course of his residence at Highcliffe in 1907. The version of these conversations, given in the *Daily Telegraph* "interview," is far from authentic, and Mr. Harold Spender's information was evidently not obtained at first hand, but more probably from German sources.

The first chapter, which is entitled "Bernhard von Bülow in World Politics," contains an account of the Chancellor's political career.

The writer contends that while everyone must agree that von Bülow is one of the most accomplished statesmen of the present day, yet his management of political affairs has not

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been remarkable for its success. The most prominent features of the Chancellor's term of office are described as the dislocation of the Imperial finances, the diminution of the national wealth by the granting of large loans to Russia, the revolt in South-West Africa, and the slow progress in the development of the navy.

He further states that the November events have resulted in diminishing the esteem in which the Kaiser has hitherto been held by his subjects.

The political state of Germany, before the November events, is dealt with in detail in the second chapter of the book. Herr Martin then depicts the events of the first few years of the present Emperor's reign, when Prince Bismarck was Chancellor. Next follow some interesting passages regarding the Kaiser's abilities, tendencies, opinions, his religious sentiments, and his endeavours to further the cause of art and science. He has given special attention to the development of the navy, and it is to a great extent due to him that the shipbuilding law, extending to the year 1917, was adopted in 1900.

The Kaiser, says Herr Martin, has from the beginning of his reign fully comprehended the value of Helgoland. Had Great Britain retained Helgoland in her possession she would have been able to blockade the mouth of the Elbe as well as that of the Weser, but, thanks to the Kaiser's foresight, Germany will now be able to make use of that island as a point of support in time of war with England or with France. Helgoland will, he thinks, gain enormously in value with the expansion of Germany's aerial fleet.

The Kaiser made the greatest mistake of his reign, according to Herr Martin, in neglecting to accept the resignation of Prince von Bülow in October, 1908.

It is this forbearance, he asserts, which has done most injury to his power and which has exposed him to most unjust criticism. From the 17th November, 1908, it appeared to the world as if public power had been transferred from the Kaiser to the shoulders of the Chancellor. But even to-day, thinks Herr Martin, if the Emperor would only consent to the dismissal of Prince von Bülow, he would once again enjoy his hereditary and constitutionally guaranteed Imperial rights.

All those, he concludes, who are desirous of a constitutional government should then insist upon an immediate change in the Chancellorship.

Defence of the Empire in Australia. By Colonel Hubert Foster, R.E. 52 pp. Fol. London, 1908. Hugh Rees. 1s. 6d.

Colonel Foster's pamphlet contains a series of eight articles, which together form a most valuable exposition of the true principles of Imperial defence.

The dependence of an Empire such as ours upon sea power is very clearly pictured, but Colonel Foster has been careful to show that there are limitations to the powers of a navy, and that a conclusive result can only be attained by the action on land of military forces.

The manner in which Imperial co-operation is urged, and in which the advantages of the offensive over the defensive have been shown, should commend the book to Imperialists and soldiers, not only in Australia, but throughout the Empire.

STRATEGICAL AND TACTICAL.

Lessons from Two Recent Wars. (The Russo-Turkish and South African Wars). By General H. Langlois. Translated for the General Staff, War Office. 145 pp., with 4 maps. 8vo. London, 1909.

Though General Langlois wrote this book five years ago, it is still of considerable value, especially as the Manchurian War has proved the soundness of many of the doctrines enunciated, without refuting any of the principles laid down. The volume was written with a view to preventing French officers from forming incorrect and dangerous conclusions as the result of the war in South Africa. The author is one of a coterie of distinguished French military writers who have been and are striving to imbue their countrymen with the spirit of the offensive, which in their opinion was the cause of the

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German victories in 1870-71. The effect produced by the Boer War was to create a feeling in certain circles that the frontal attack had become impossible. As a result of this it seemed likely that French military opinion would veer round to something like its condition in 1870, when so many battles were lost by a want of initiative and a passive defensive attitude. General Langlois therefore set himself to combat these dangerous tendencies by exposing the fallacies of lessons derived from South Africa, further illustrating his contentions by means of examples from the Russo-Turkish War of 1877-78.

He wrote before the conclusion of the *entente cordiale*, so that his criticisms are not blunted by any desire to be polite to us. His tactical ideas, written before the Manchurian War, have been borne out by the success of the Japanese, who acted in accordance with his views. Throughout he lays very great stress on the value of the offensive, of initiative, of energy, and of a determination to conquer; his doctrines are those of our training manuals, with special reference to certain points, which he has brought out with great clearness and ability.

The book is full of valuable criticisms and important lessons. It is divided into five parts, the first dealing with the Russo-Turkish War, the second with considerations regarding the teachings of the French drill book, the third with the Boer War, the fourth with lessons to be drawn from the latter, and the fifth with general considerations regarding present-day tactics.

The author's remarks on the Russo-Turkish War are valuable, especially in the way that they lead up to the discussion on the French drill book in Part II. of the work. This discussion deals more particularly with Skobelev's operations in the fighting about Plevna, with the development of the attack, the fire fight, and the final assault; stress is laid on the importance of adequate artillery support to attacking infantry, and the value of the moral factor is emphasized.

General Langlois divides the South African War into three periods:—(1), Before the arrival of Lord Roberts; (2), after his arrival; (3), after his return to England. He maintains that the actions fought by General Buller round Ladysmith, *e.g.*, Colenso, Spion Kop, etc., and by Lord Methuen at Belmont, the Modder River, and Magersfontein, were conducted in defiance of the lessons of 1877-78, and indeed of all tactical rules; he enumerates the various mistakes committed by our leaders, and emphasizes more especially the want of co-operation by the artillery, the faulty notions as to the delivery of the decisive attack, the want of mutual support, the lack of energy and of a determination to conquer. Having demonstrated the fact that our failures were due to these mistakes and not to the increased power conferred on the defence by modern improvements in firearms, General Langlois goes on to make it clear that Lord Roberts' operations, though successful, have little or no bearing on the tactics of European warfare, whilst the guerilla fighting of the third period can be entirely neglected. At the same time however he affirms his opinion that a decisive battle, however costly, would in the long run have proved far more economical in men and money than the cautious measures adopted by the British commanders.

Part IV. deals with the lessons of the South African War, and is an extremely able discussion. The author points out the danger of drawing false conclusions from the Boer War, where the circumstances were peculiar, and quite different to those obtaining in European warfare, where one side was practically composed of irregulars, whilst the tactical methods employed by its opponents were antiquated, vicious, and irresolute. He shows that there is no reason to suppose that frontal attacks will be impossible in the future, with the aid of good leadership and with efficient artillery support; he deprecates the cult of mounted infantry, which he considers to be merely a cheap and bad form of cavalry, and whilst acknowledging the frequent necessity of dismounted action, urges that the *rôle* of cavalry has gained in importance, and that the horsemen of the future require more careful training and must be better riders than ever before. He goes on to deal with German and British tendencies after the South African War, and comes to the conclusion that the Napoleonic system remains the best, *i.e.*, to employ strategy to bring about a battle, during the battle to engage the enemy all along the line, but to drive home the attack at one point. Finally, he discusses our training regulations, compares them with the French regulations, and arrives at the decision that it was failure t observe the principles laid down in our training manuals that led to our checks an

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repulses in South Africa. He concludes with a few remarks *re* howitzers, heavy guns, and pom-poms.

The final chapter, dealing with the evolution of tactics, enumerates a few important laws which have been established as the result of the improvements in modern firearms. General Langlois points out that these improvements tend to increase the value of the individual, as opposed to the power of mere numbers, and that energy, *moral*, and determination to conquer will play an even greater part in future wars than has been the case in the past.

THE SURPRISE ATTACK BY SEA AS A PRELIMINARY TO A CAMPAIGN (Der Ueberfall über See als Feldzugseinleitung). By Lieut.-General A. von Janson. 144 pp., with 14 sketch maps and plans in the text. 8vo. Berlin, 1909. Eisenschmidt. 4s.

The question of an invasion by sea is one of the most discussed topics of the present day. This is to some extent due to the important part played by the Japanese fleet in the recent war against Russia. In this book various oversea expeditions which have taken place in the past are dealt with, and the lessons to be learnt from them are discussed.

Napoleon said: "To try and effect a landing in England without having command of the sea would be the boldest and most difficult operation that could be attempted." Nevertheless the French expeditions to Ireland and Egypt prove that under favourable circumstances it is possible for a nation not having command of the sea to land troops.

The telegraph and other modern inventions prevent preparations for such expeditions being kept secret at the present day, but otherwise the author considers that the improvement in ships, armaments, etc., confer equal advantages on the assailant and defender. No modern ruler or general has given more attention to the question of invasion than Napoleon, and yet he was only successful once (Egypt). Even on this occasion, had not the French fleet been destroyed, it is questioned whether the expedition would have had any lasting results. Napoleon succeeded in transporting an army all the way to Egypt, and yet hesitated to cross the Channel, because England had command of the sea. The author therefore concludes that what Napoleon, who was much more favourably situated, was incapable of doing could not be done by anyone at the present day, and also that oversea invasion in Europe is practically out of the question. This theory appears to be confirmed by the Russo-Japanese War, when the Japanese hesitated to land on hostile territory until they had gained command of the sea, notwithstanding the fact that they had surprised their opponents both politically and strategically.

It is not considered that any Power could collect sufficient transports to carry in one trip an army of sufficient size to bring a war to a decision. The author considers that railways are a great safeguard against such landings, and that a country which has made the necessary preparations for its own defence in peace time has nothing to fear from oversea attacks. This he considers a much greater safeguard than International conventions.

GENERAL CARL VON CLAUSEWITZ ON WAR. Translated by Miss Maguire, with notes by T. M. Maguire. 161 pp., with 2 maps. 8vo. London, 1909. Clowes. 7s. 6d.

This book consists of a series of articles published originally in the *United Service Magazine*.

The selected extracts from this distinguished authority on the art of war have been freely translated, and in many instances only a *précis* of the original text is given. Interspersed throughout the articles are copious comments and notes by Mr. Maguire, who has drawn on British methods and military history, as far as possible, by way of illustration.

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STUDIES OF WAR (Studien über den Krieg). Part III. Strategy. By General of Infantry J. von Verdy du Vernois. 99 pp., with 3 maps in text. 8vo. Berlin, 1909. Mittler. 2s. 6d.

This is the eighth number of the series and the third section of the second group dealing with strategical operations. The subject dealt with in this number is the "Strategical Concentration," with comments on von Moltke's appreciations on the question.

The author points out in the introduction that concentration must be considered under the headings of strategical and tactical, and illustrates his arguments from the campaigns of 1859, 1866, and 1870.

SOME PRINCIPLES OF FRONTIER MOUNTAIN WARFARE. By Brevet Major W. D. Bird, D S.O. 41 pp., with 2 plans. 8vo. London, 1909. Rees. 1s.

A brief treatise on the rules to be observed in campaigning on the North-West Frontier of India. Divided as follows :—

(1). General considerations.
(2). Strength and organization of columns.
(3). Marches and protection.
(4). Action of advanced and rear guards.
(5). Attack and defence.
(6). Camps.
(7). Protection of lines of communication.
(8). Defence of a post.

Under the above headings the writer considers how dispositions are affected by the nature of the country and the military capabilities of the tribesmen ; by space occupied by columns on narrow hill tracks, and the probabilities of resistance ; the protection of columns by picqueting hills, and the disposition of troops on the line of march and in advanced and rear guards ; the precautions to be observed in posting and withdrawing picquets ; the occupation of successive positions by rear guards ; the importance of offensive action and flanking movements ; how best to bring the tribesmen to action so as to inflict losses upon them ; the importance of systematic defence in withdrawal. The part on camps deals with their form and choice of situation, picqueting, the nature of entrenchments, and the disposition of the three arms. The part on the protection of lines of communication discusses the relative use of defensive posts and flying columns.

PROVISIONAL REGULATIONS REGARDING THE METHODS OF CROSSING AND DESTROYING OBSTACLES (Instruction provisoire sur les procédés de franchissement et de destruction des obstacles de la fortification). Official publication issued by the French War Office. 47 pp. 8vo. Paris, 1908. Imprimerie nationale. 10d.

The object of these regulations is to indicate the technical rules to be followed, the implements to be employed, and the formations to be adopted by detachments who have to cross or destroy obstacles in the presence of the enemy.

The regulations are divided into three parts, namely :—

First part, dealing with the crossing and the destruction of the principal accessory defences.

Second part, dealing with the crossing of ditches and surmounting of stockades and railings.

Third part, dealing with the destruction of stockades and railings.

It is laid down that obstacles can as a rule only be crossed or destroyed at night, though instances may occur when it may be necessary to attempt such operations in daylight under cover of artillery and rifle fire. The regulations insist that in any case it is absolutely necessary that the work must be carried out with very great rapidity, and that the plan for reaching the obstacles must be very simple. The clearest orders are given as to the strength of detachments sent out to destroy obstacles, the *matériel* they are to take with them, and the simplest method of carrying out each particular class of demolition.

The regulations are illustrated by means of clear diagrams.

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TRAINING AND EDUCATION.

MISTAKES IN THE SOLVING OF TACTICAL PROBLEMS. By Lieut.-Colonel J. Layland Needham. 66 pp. 8vo. London, 1909. Rees. 1s. 6d.

This is the second edition of this little work. It is a useful collection of the more frequent mistakes committed by candidates in the tactical papers set in examinations for promotion, as pointed out by the examiners in their reports, with explanatory notes by the author.

The example of orders given on pages 65—66 is not quite in accordance with *Field Service Regulations*, Part I., which has been issued since the publication of this book.

FORTIFICATION AND MILITARY ENGINEERING.

ARMOUR IN FORTIFICATIONS (Fortification cuirassée). By Lieut.-Colonel L. Piarron de Mondésir. 360 pp. 8vo. Paris. Octave Doin. 4s. 2d

The author traces the effect of the introduction of melinite more than 20 years ago, and shows how metal has come to be employed in fortifications in order to furnish protection to the guns and gun detachments, and to observation parties and sentries. The book is divided into two parts, the first of which deals with the improvements in weapons in the XIXth century, and the effect produced by these on fortifications. The second part deals with the employment of armour in fortifications at the present time in France.

A TREATISE ON PERMANENT FORTIFICATION (Étude sur la Fortification Permanente). By General Dupommier. 56 pp., with 1 plate. 8vo. Paris, 1907. Berger-Levrault. 1s. 8d.

This book contains four chapters, dealing respectively with the *rôle* generally played by permanent fortifications, with "forts d'arrêt," fortifications as a means of protection, and "covering" fortifications.

BOOKS OF REFERENCE.

THE TERRITORIAL YEAR BOOK. 294 pp. 8vo. London, 1909. Hodder & Stoughton. 2s.

This book deals primarily with the constitution, organization, administration, and distribution of the Territorial Forces, but there is also a considerable amount of up-to-date information on matters of general military interest.

It contains lists of the Military Forces of the Crown, the principal ships of the Royal Navy divided according to classes, regiments of the Army, with historical notes, Territorial units, and county associations.

Maps have been supplied, showing the division of England, Scotland, and Wales into Territorial commands, districts, etc., and coast defence zones.

It will be found a useful and interesting publication by all, but especially by members of the Territorial Force.

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TRAVEL AND TOPOGRAPHICAL.

THE SHORT CUT TO INDIA. David Fraser. 381 pp., with 90 illustrations, maps, and sketches. 8vo. Edinburgh and London, 1909. Blackwood. 12s. 6d.

This is an entertaining and instructive account of a journey along the route of the Baghdad Railway. The chapter dealing with the railway convention and the last four chapters dealing with the route of the railway, the population question, mail contract and gulf shipping, and the general question of the railway are of peculiar interest from a military point of view.

MISCELLANEOUS.

GERMAN SECRET SERVICE IN FRANCE (L'espionnage allemand en France). By Paul Lanoir. 250 pp. 8vo. Paris, 1908. Cocuaud & Co. 3s.

An interesting work, showing the organization, ramifications, and working of the German secret service system, from 1848 up to the present day, with special reference to the methods of Stieber. This extraordinary man, for many years head of the Prussian secret police, organized a most efficient system of spies in Austria and France before the campaigns of 1866 and 1870 respectively, and the work of these agents contributed in no small degree to the success of the Prussian and German armies in these wars.

The author goes very deeply into the German methods of secret service, and the information given by him is of considerable value, as it shows the thoroughness of the German system, and the lengths to which Germans are prepared to go when they require intelligence about a country on which they intend to make war. The details of present-day German methods are most instructive, and the book is well worth reading.

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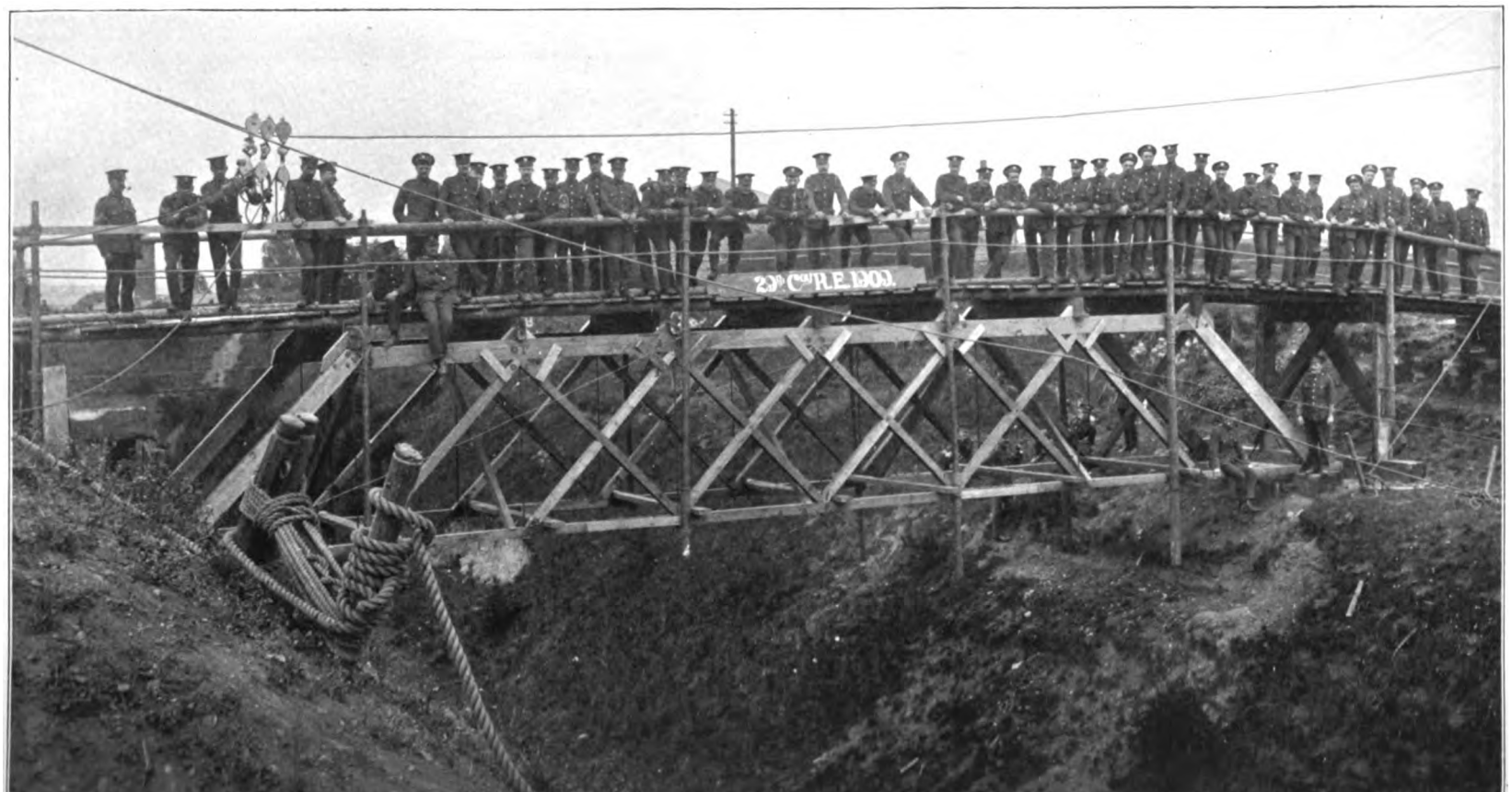
A LIGHT GIRDER BRIDGE.



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A LIGHT GIRDER BRIDGE.

By CAPT. G. R. PRIDHAM, R.E.

THE following short description of a bridge made by the 29th (Line of Communications) Company on its annual course in 1909, may prove of interest, and though the conditions under which it was made are perhaps not applicable to most companies in war, cases may arise in which similar conditions will prevail.

A line of communications company establishes a strong "workshops section" at railhead, and its equipment includes plant for erecting a fairly complete workshop. This workshops section can complete a job for which machinery is required, and the finished material is then sent out for erection either by its other sections or by other companies. Although under ordinary circumstances a field company would not have the advantage of such a section, it might possibly take over an existing shop, and thus be able to construct a bridge similar to the one described below.

In the present instance, as there are no detailed standard designs laid down for light girders—and only light girders could be erected away from a railway—the dimensions, etc., were worked out from first principles, so as to be as light as possible. It will be seen that no heavy parts are required, and every piece could easily be carried in a wagon or cart. The erection too only requires light spars, which could be transported in the same way. For this reason such a bridge might be well worth making up and sending out for erection in a wild and treeless country.

The bridge is designed to carry infantry in fours, crowded at a check, and will also take a concentrated rolling load of $2\frac{1}{2}$ tons distributed on two pairs of wheels.

The drawings (see *Plate*) were put into the hands of the carpenters and smiths. Materials were all drawn in bulk, *i.e.*, the timber had to be sawn, and all bolts, ties, etc., made out of round iron. The remainder of the company worked on the site, where footings had to be prepared and arrangements made for launching the girders. A small sheers 15′ high was put up on each bank, and a 3″ steel wire rope stretched across the gap. Behind these sheers

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a derrick was erected on each side to hold the head and tail of the girder.

Each girder weighed about a ton, and had to be very carefully handled to avoid distortion. The launching presented little difficulty. Three travellers were rigged to the steel rope, and to each traveller a block and tackle was fixed. The girder was slung to the travellers in three places and, when it had been hauled out, was lowered on to its footings.

Each girder was fitted carefully in the workshops, and the pieces which came together were lettered, so that they could be put together quickly on the site. By the end of the fourth day both girders had been made, transported to the site, and launched into positions. Distance pieces were then put on at every joint in the bottom boom, and the sleepers which were used as road transoms, were laid and fixed to the joints of the upper boom. Diagonal struts were nailed between the girders to stiffen the bridge.

The roadway was finished as for an ordinary field bridge. A camber of 2″ had been put onto the girders when the tie rods were screwed up. The bridge was loaded to its full working load of 5 cwts. per foot run, and this took about 1″ off the camber. No sign of weakness was seen in any part under the load.

Some of the work may appear to be too elaborate for a field bridge, and no doubt various expedients may suggest themselves for the joints. These latter must however be perfectly rigid.

The excuse for putting forward this bridge is that the subject of really light girders has not been much studied, and this experiment may therefore prove useful.

The following are the detailed calculations for the bridge :—

Span.—52′.

To carry infantry in fours, crowded at a check, and carriages, up to a weight of 2½ tons, distributed on two axles.

The depth between bottom edge of top boom and top edge of bottom boom is fixed at 6′ 6″, and this is also the width of panels from centre to centre of tie rods.

From simple stress diagrams we arrive at the stresses in each member as follows. It is also found that the four centre panels need cross-bracing.

Maximum compression top boom ...	...	...	8	tons.
„ tension bottom boom ...	...	...	8	„
„ „ in tie rods ...	...	...	2½	„
„ compression in struts ...	...	...	4	„

Top Boom.—Considered as a column.

Reference, *Principles of Structural Design*, Part I., p. 160.

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$$P = \tfrac{1}{2} r_c \times A, \text{ from Formula (4)};$$

$$l \text{ is } 6' + l = 4''.$$

$$P = 8 \text{ tons}, \; r_c = 5{,}400 \text{ lbs.},$$

or $\tfrac{1}{2}$ ton, with a F. of S. of 4 to 5.

Assume the breadth of the strut to be 4″.

Then $$8 = \tfrac{1}{2} \times \tfrac{1}{2} \times 4d.$$

$\therefore$ $$d = 8''.$$

For Struts.—Taking the cross-bracing as struts fixed at the centre where they cross. From Formula (3), reference as above,

$$4 = \tfrac{5}{6} \times \tfrac{1}{2} \times 4d.$$

Taking the breadth to be 4″,

$$d = 2\tfrac{1}{2}'' \text{ approximately.}$$

For the end strut, which is not braced, from Formula (4), reference as above,

$$4 = \tfrac{1}{2} \times \tfrac{1}{2} \times 4d.$$

$\therefore$ $$d = 4''.$$

Bottom Boom.—Tensile strength for red pine = 12,000 lbs. Sectional area with a F. of S. of 5 is

$$\frac{8 \times 2240 \times 5}{12000}$$

$$= 8 \text{ sq. ins.}$$

Tie Rods.—Tensile strength for W.I. = 22 tons. Sectional area with a F. of S. of 5 is

$$\frac{2\tfrac{1}{2} \times 5}{22}$$

$$= \cdot 57 \text{ sq. ins.}$$

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For convenience of jointing, some of the members are made of larger dimensions than is necessary for strength.

The calculations for each important joint were also carefully worked out, and for these a table in Hurst's "Architectural Surveyors' Hand Book," p. 44, was used, which gives the compression required to compress wood $\frac{1}{20}''$. Anything beyond this would lead to distortion of the girders.

The holding power of nails given in "Notes on Building Construction" (Rimington) is also a useful fact in a rough job of this kind.

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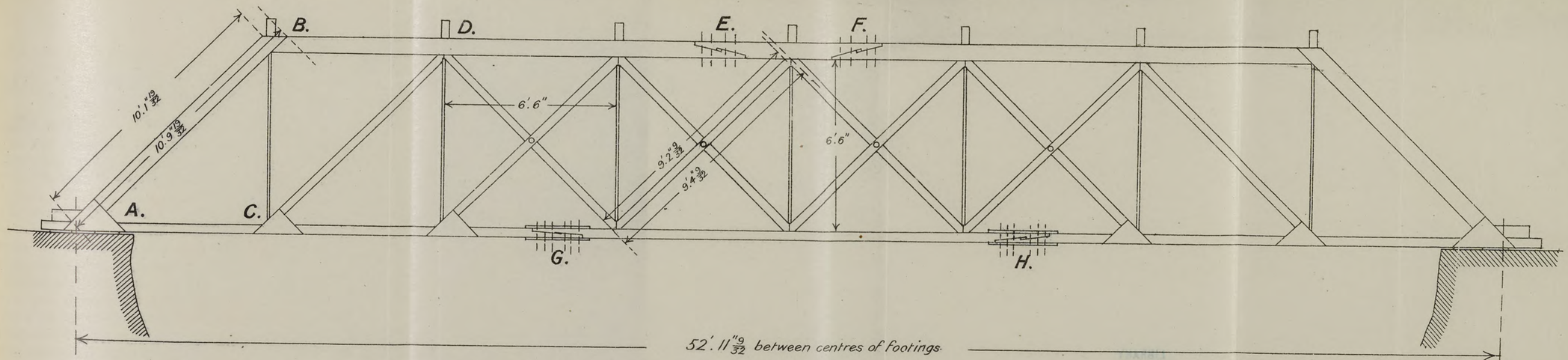
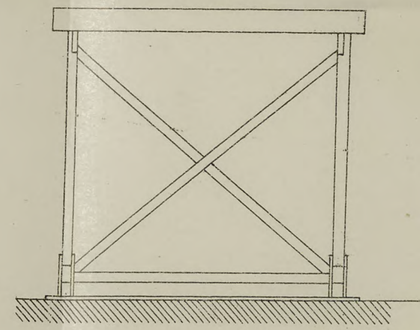
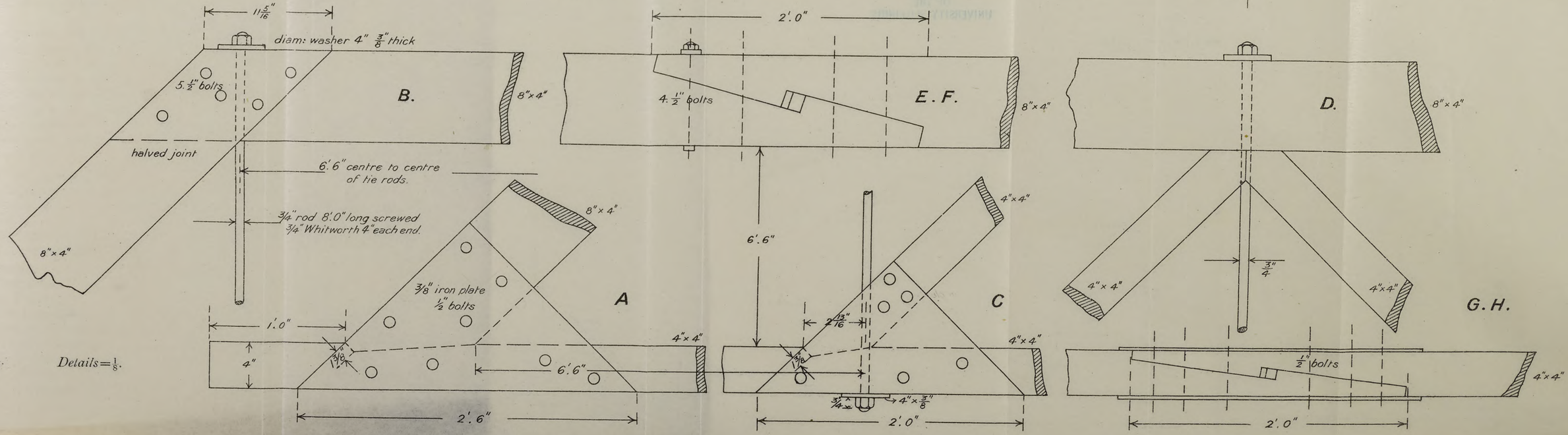
A LIGHT GIRDER BRIDGE.





52'. 11 9/32 between centres of footings.



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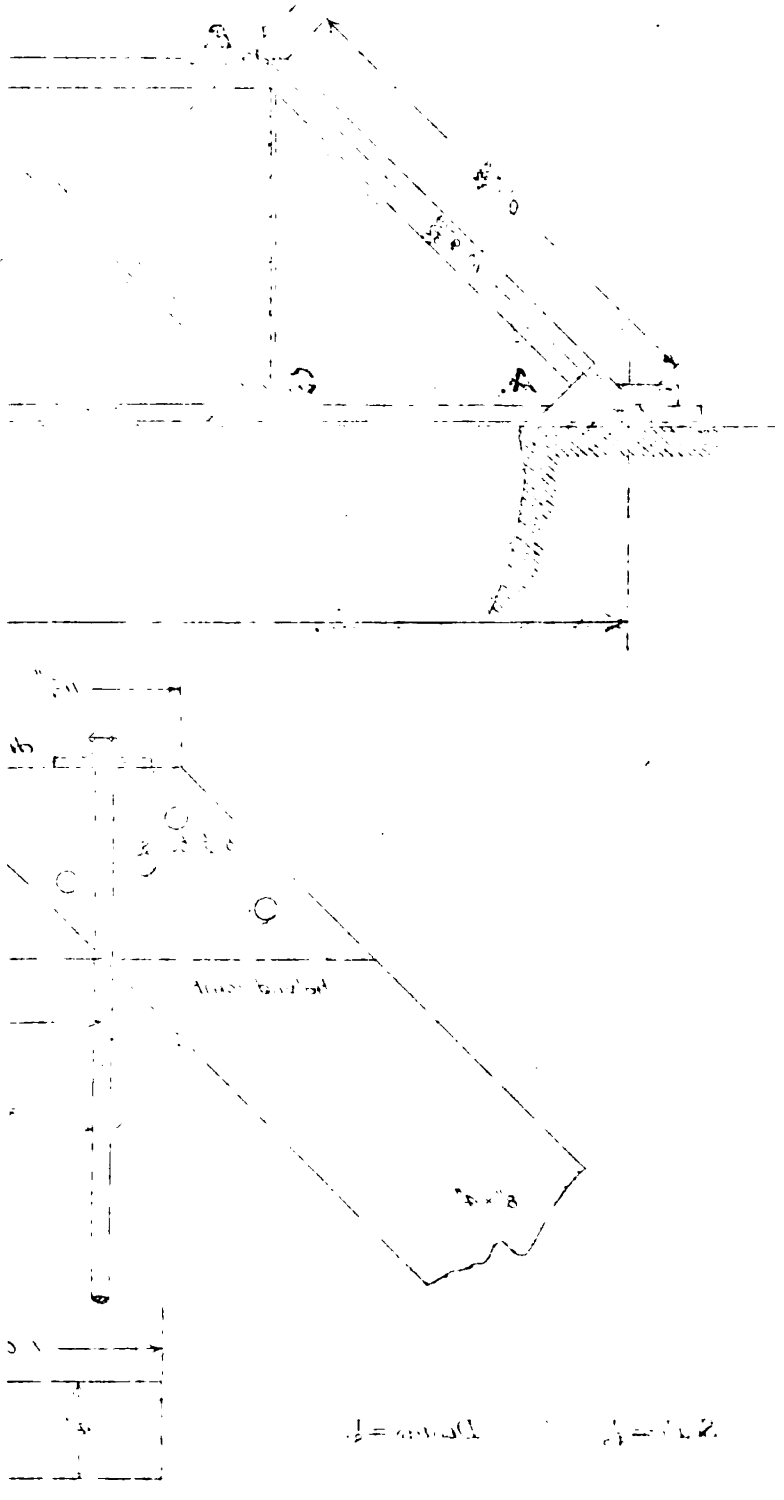

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GENERAL PRINCIPLES OF ORGANIZATION AND EQUIPMENT, ROYAL ENGINEERS.

INTRODUCTION.

IN the May, June, and July numbers of the *R.E. Journal* of 1896, Colonel (then Major) G. H. Sim contributed a most valuable article on the "General Principles of Organization and Equipment, Royal Engineers." So many changes have taken place of late years not only in the organization of the Corps itself but also in the composition and equipment of the various units, that the details given by Colonel Sim are now of little practical use; but as the paper for many years proved of such value, its complete revision has been suggested.

This has now been done, the C.E., Aldershot, kindly undertaking the revision of the Field Units, and the D.G.O.S. having corrected those of the Survey Companies. The portion referring to recruiting, mobilization, etc., has also been carefully revised, but as regards the latter, constant changes are made in the regulations and reference should therefore be invariably made to mobilization regulations, field army tables, etc.

It has not been possible, unfortunately, to follow strictly on the lines of the original article, which dealt with the subject in the following order:—(1). General scope of duties. (2). Establishments. (3). Organization and duties in connection with Engineer services in peace. (4). Regimental organization and equipment for peace and war. (5). Conditions of service and enlistment. Both Nos. (1) and (3) of these are dealt with in the "Regulations for Engineer Services," which is at present under revision, and it is proposed therefore to deal with them later on.

I. ESTABLISHMENTS.

In the "Army Estimates" of 1909–10 the Corps of Royal Engineers is given as consisting of 1,051 officers and 8,739 warrant officers, N.C. officers and men.

The *Regimental Establishments* of the Corps comprise the following units (see "Regimental Establishments, 1909–10"):—

(*a*).	Field Troops	5
(*b*).	Field Companies	15
(*c*).	Bridging Trains	3
(*d*).	Telegraph Companies:—	
	(1). Air-Line Companies...	2
	(2). Cable Companies	2
	(3). Divisional Companies (including 3 Cadres)	7
	(4). Wireless Companies...	1
	(5). K Company (Postal Telegraphs)	1

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(*e*). Balloon School... 1
(*f*). Searchlight Company... 1
(*g*). Railway Companies 3
(*h*). 29th Fortress (Line-of-Communication) Company... 1
(*i*). Fortress Companies—Home 13
„ Coast Battalion 2
„ Abroad 15
(*j*). Survey Companies 3
(*k*). Depôt Companies (1) at Chatham 9
(2) at Simla 1
(*l*). Training Depôt for Field Units 1
(*m*). Colonial Survey Section 1
(*n*). Instructional and Supernumerary Staff and Permanent Staff for Special Reserve and Territorial.

The following table gives the numbers in the *Army Estimates*, 1909–10, pp. 12, 18, and 24 :—

Unit.	W.O.'s, N.C.O.'s, and Men.	Horses & Mules.
1. Field Troops 5	344	260
2. Field Companies 15	2132	330
3. Bridging Trains 3	24	—
4. Telegraph Companies 11	800	336
5. Balloon School 1	137	36
6. Searchlight Company 1	88	45
7. Railway Companies 3	229	—
8. Fortress (Line-of-Communication) Company 1	60	—
9. Fortress Companies 28	2506	—
10. Coast Battalion Companies ... 2	90	—
11. Survey Companies... 3	342	—
12. Depôt Companies, Fortress ... 9	880	—
13. Field Depôt 1	262	76
14. Colonial Survey Section 1	4	—
15. Regular establishment for Royal Reserve Engineers...	46	—
15. Staff for Colonial Garrisons, Works Services, etc.	718	—
15. S.M.E., etc.	55	—
15. War Office and General Requirements...	22	—
15. India	3	—
Total	8742	1083
Fortress Companies—Hong Kong	50 } Natives.	
Sierra Leone ...	45 }	

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Unit.	Officers.	W.O.'s, N.C.O.'s and Men.
Home :—		
Including Regular Establishment of Special Reserve, Permanent Staff of Militia and Territorial Force ...	492	6650
Colonies and Egypt :—		
Including Permanent Staff of Militia	183	2247
India	376	3
Total	1051	8900

Indian Establishment.—There are, besides the above, the following units on the Indian Establishment, composed and officered by natives, but under the command of R.E. officers, and with a few warrant and N.C.O.'s from the British Establishment :—

1st (Prince of Wales') Sappers and Miners :—6 Companies, Pontoon, Mounted, and Telegraph Detachment, 1 Depôt and Experimental Balloon Section.

2nd (Queen's Own) Sappers and Miners :—7 Companies and 2 Depôt Companies.

3rd Sappers and Miners :—7 Companies and 2 Depôt Companies.

Railway Companies :—2.

II. Regimental Organization and Equipment for Peace and War.

The Regimental Establishment units have been already mentioned on p. 317.

They are for the most part organized for supplying the details necessary for active service, but are also arranged that their services may be utilized to the utmost in technical employment during peace.

FIELD TROOPS.

There are at present five field troops, one each at Aldershot, Canterbury, the Curragh, and Chatham, and one in South Africa. The four troops at home are allotted on mobilization to the cavalry division of the Expeditionary Force as Divisional Engineers, with the officer commanding R.E. troops and companies as Commanding Royal Engineer of the division. During peace, each troop is attached to one of the brigades of the division, for its own training and for the instruction of the cavalry pioneers of the brigade.

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Establishment.

	Officers.	N.C.O.'s & Men.	Horses.	Vehicles (Peace and War).	No.
Peace ...	3	69	52	Double tool carts	2
				Spring wagons	2
				G.S. wagon	1
War ...	3	78	81	Boat wagon	1
				Water cart	1

A field troop is organized into half-troops. About half the sappers are mounted, the remainder being carried in the spring wagons.

The duties of field troops in war with the cavalry division are mainly :—

Demolition and hasty repair of bridges, railways, and telegraphs; hasty field defences; passage of rivers and obstacles; water supply and camping arrangements.

Assistance in carrying out these duties may be obtained from the cavalry pioneers, of whom there are at least 12 in each squadron.

Principal Tools and Stores.

	No.		No.
Anchors, boat, 46 lbs. ...	1	Detonators, electric, No. 8	250
Axes, felling	26	Exploders, dynamo ...	2
„ pick	40	Forge, field	1
Bags, sand, common ...	264	Fuze, safety, fathoms ...	96
Bars, boring	6	Guncotton, dry primers, 1 oz.	480
„ crow	6	„ wet, slabs, 15 ozs. slabs	280
Blocks, tackle, 1½" cordage	10		
Boats, collapsible, bow, sections	2	Hooks, bill	19
Boats, collapsible, stern, sections	4	Lashings, tarred	55
Boats, collapsible, oars	12	Pumps, lift and force ...	2
Boats, collapsible, skids, raft ...	2	Saws, cross cut	2
Boats, collapsible, „ ramp ...	2	„ hand	16
Cable, electric, D.14, yds....	1000	Shovels, R.E.	39
„ D.15, „ ...	660	Telephone, sets	3
Cordage, hemp, fathoms ...	359	Troughs, waterproof, 600 gallons	2
Cutters, wire	18		
Detonators, electric, No. 13	100		

The tools and demolition equipment are carried in the two double tool carts and on five pack animals. The canvas boats each consist of three folding sections, and with the superstructure are capable of making up one raft to carry any gun or vehicle with the cavalry division.

A new equipment, with a steel punt and air-bags with raft superstructure, is now under trial.

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FIELD COMPANIES.

Field companies now form part of the divisional troops, two being allotted to each of the six divisions of the Expeditionary Force, and these, together with the divisional telegraph company, are under the command of the Divisional C.R.E.

Of the 15 field companies 12 are thus accounted for; the remainder are abroad—two in South Africa and one in Egypt. The stations of home companies are as under :—

2 companies with	1st	Division,	Aldershot and Bordon.
2 „	2nd	„	Aldershot.
2 „	3rd	„	Bulford.
2 „	4th	„	Shorncliffe and Colchester.
2 „	5th	„	Curragh.
2 „	6th	„	Kilworth and Cork.

The establishment is as follows :—

	Officers.	N.C.O.'s and Men. Mounted.	Dismounted.	Horses.	Vehicles.
Peace	3	26	116	25*	13
War	6	49	157	73*†	13

and in addition, when mobilized, 1 A.S.C. driver for the water cart and 2 rank and file, R.A.M.C., for water duties are attached.

The vehicles consist of :—

4 double tool carts.
4 forage carts.
1 G.S. wagon.
2 pontoon wagons.
1 trestle wagon.
1 water cart.

All the above, except the water cart, are 1st line transport.

At war strength, the company consists of headquarters and four sections. The former comprises the major, captain, staff-sergeants, trumpeter, bugler, shoeing and carriage smith, and five sappers. The vehicles attached are the G.S., pontoon, and trestle wagons, and water cart.

Each section is commanded by a subaltern (one horse), and consists of 1 sergeant and 36 dismounted rank and file, 6 mounted men

* Includes officers' horses.
† Includes 2 horses for water cart.

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(one riding horse), 9 horses (of which one carries pack equipment), 1 double tool cart (four draught horses), and 1 forage cart (two draught horses), so that each section may be regarded as self-contained as regards its transport, and can be readily detached for special duty.

In the tool carts are packed entrenching and carpenters' tools, explosives, regimental reserve S.A.A., water supply stores, blocks and tackle, cordage and small stores. The forage carts contain also some explosives and heavier tools, but chiefly serve to carry rations, forage, blankets, camp equipment, etc., sufficient for the wants of the sections. The pack gear consists of explosives and tools necessary for demolitions. Similarly, the G.S. wagon provides for the requirements of the headquarters, carrying in addition artificers' tools and materials for repairs, a forge, signalling and sketching equipment, quartermaster's stores, etc., etc.

The bridging equipment comprises two pontoons and two Weldon's trestles, and is sufficient to provide 60′ of medium bridge, or two trestle piers and a raft of two pontoons.

All the equipment, except the explosives, is in company charge, though the special requirements for mobilization are stored apart. The explosives are in charge of the A.O.D., and stored ready for immediate issue; thus when orders for mobilization are received the stores are on hand, and practically nothing has to be indented for from the ordnance stores.

The equipment of a field company is sufficient for it to undertake any small engineering operation which may be required, such as construction of field defences, blockhouses, small repairs to roads, bridges, and railways, demolitions, crossing small streams, and so on; but the tools are necessarily limited, and for large works and extensive repairs resource would have to be made to the A.O.D. for additional tools and materials. The two field companies carry sufficient water supply gear for a division.

Since the abolition of the Bridging Battalion and introduction of bridging trains an important duty has fallen upon the field companies; they will now be responsible for the construction and maintenance of pontoon bridges, the bridging trains only supplying the material.

The composition of a field company, as regards its *personnel* and transport and stores, is set out in detail in the *Manual for Field Service :—Engineers. Field Company.* 1908.

In peace time field companies are kept pretty busy most of the drill season with musketry, fieldworks, and pontooning, and with manœuvres, which they carry out with their respective divisions. The officers, in addition, have generally district work under the Divisional C.R.E., and the men, when not being trained as above, are employed in the sub-district workshops and on the works.

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The chief stores and tools with a field company are shown below:—

Sandbags	852	Pontoons, bipartite, complete	2
Fuze, safety, No. 9 ... fthms.	224	Weldon's trestles	2
Guncotton, 1 oz. primers ...	720	Baulks	21
„ wet slabs, 15 oz.	560	Chesses	70
Detonators, No. 8	400	Cable, electric, unarmoured yards	1760
„ electric, No. 13	200	Heliographs, 5″	2
Exploders, dynamo... ...	4	Signalling lamps, "B" ...	2
Holdalls, tool, R.E., with carpenters' and smiths' tools	8	„ glass	8
Holdalls, saddlers'	1	Grindstones	5
Axes, felling	48	Field levels...	4
„ hand	28	Cordage, white, 2″ ... fthms.	224
Pickaxes, 8 lbs.	19	„ „ 1½″... „	280
„ 4½ lbs.	89	Pumps, lift and force, to lift 60′, complete with hose	4
Shovels, R.E.	113	Hose, delivery, spare ...	8
Spades, Mark III.	19	Troughs, 600 gallons, waterproof, with stand or pickets	4
Bars, boring, 1½″ × 4′ long ...	8	Saws, cross-cut, 5′... ...	4
„ 1½″ × 2½′ „ ...	12	„ hand	27
„ crow, 4½′	8		
Billhooks	40		

and a large number of other tools and materials and small stores.

BRIDGING TRAINS.

Two bridging trains are included in the army troops of the Expeditionary Force. The war establishment of a bridging train provides for the necessary mounted men and horses for transport of the bridging material, and includes a small proportion of dismounted artificers for carrying out repairs to the equipment.

War Establishment of a Bridging Train.

Officers.	N.C.O.'s and Men.		Horses.	Vehicles.	No.
	Dismounted.	Mounted.			
7*	22	202	331	Pontoon wagons ...	32
				Trestle wagons ...	8
				G.S., R.E., wagons ...	4
				Maltese cart	1
				Water cart	1

* Includes 1 medical officer and 1 veterinary officer.

The full equipment for the two trains is maintained in peace, and is available for the training of field companies in pontooning.

The peace establishment of *personnel* consists of three cadres, each of 1 company quartermaster-sergeant (mounted branch) and 7 artificers.

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The 1st and 3rd cadres, with equipment for the 1st Bridging Train, are at present stationed at Aldershot and Christchurch, and the 2nd cadre and equipment for the 2nd Bridging Train are temporarily at Chatham and Limerick, but are intended for the Irish Command.

Mounted cadres for the two trains, each consisting of 2 sergeants, 1 corporal, and 1 second corporal, are also maintained in peace, and are attached to the Training Depôt at Aldershot.

The equipment of a bridging train consists of 32 pontoons and 32 bays of superstructure, carried in 32 pontoon wagons; also 16 trestles and 8 bays of superstructure, carried on 8 trestle wagons. This provides sufficient bridging material for 200 yards of medium bridge. Artificers' tools and material for repair to the equipment are carried in the G.S. wagons.

AIR-LINE TELEGRAPH COMPANIES.

The two air-line companies are allotted to the army troops of the Expeditionary Force. One company is stationed at Aldershot, and the other at Limerick.

Establishment of an Air-Line Telegraph Company.

In	Officers.	N.C.O.'s and Men.	Horses.	Vehicles.	No.
Peace ...	4	129	52	Air-line wagons ...	12
				Cable wagons ...	3
				Light spring wagons	3
War ...	6	217	158	G.S., R.E., wagons ...	4
				Water cart	1

The company is organized in headquarters and three sections, with a subaltern in charge of each section. A section is subdivided into two detachments, with a senior N.C.O. in charge of each detachment.

The peace establishment provides for a headquarters and three sections—(four detachments; Nos. 1 and 2 Sections have only one detachment)—and, in addition, for the clerks and linemen required for the maintenance of 8 telegraph offices and 80 miles of line. The war establishment provides for a headquarters and three sections—(six detachments)—and, in addition, for sufficient *personnel* to maintain 12 offices and 120 miles of line.

A detachment has two air-line wagons, each equipped with 5 miles of air line, 1 second-class Morse office, and tools for 1 lineman. One of the two wagons also carries a complete set of construction tools for the working party. Each section has a cable wagon, carrying 8 miles of cable and 2 vibrator offices, but no *personnel* additional to the air-line detachments is provided for its laying and maintenance.

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The total equipment of the air-line company comprises 60 miles of air line and 24 miles of cable, with 12 second-class Morse and 6 third-class vibrator offices.

General Employment.—During active operations air-line companies provide telegraph communication between the advanced depôt and C.-in-C., and between the C.-in-C. and any force acting independently along a line of communication of its own. It is their duty, in conjunction with the cable companies, to arrange that at the close of a day's operations the headquarters of the C.-in-C. are in communication with the most advanced Line-of-Communication Telegraph Company's Office.

They are also required to replace cable communications during sieges or prolonged operations.

Rate of Progress.—The rate of progress of air line varies from ½ mile an hour in close country to 2 miles an hour in open country. Assuming that the rate of advance of an army is 15 miles a day, four air-line detachments would be required for the erection o the line.

CABLE TELEGRAPH COMPANIES.

There are two cable telegraph companies provided for in the establishment of the Expeditionary Force, both of which are allotted to the army troops, their function being to keep the C.-in-C. in the field in telegraphic communication with the general officers commanding divisions.

In peace, the 1st Cable Company is stationed at Aldershot, and the 2nd Cable Telegraph Company at Limerick.

Establishment of a Cable Telegraph Company.

In	Officers.	N.C.O.'s and Men.	Horses.	Vehicles (Peace and War).	No.
Peace ...	3	72	46	Cable wagons ...	9
				Light spring wagons	9
War ...	6	166	123	Water cart	1

The company is divided into headquarters and four sections, each section being further subdivided into two working detachments. Each detachment consists of about 15 N.C.O.'s and men, and has 1 cable wagon and 1 light spring wagon and material for laying down and working a line of cable 10 miles long. Each line is equipped with 1 stationary office for the starting point, 1 movable office in the cable wagon, and a third office in the light spring wagon. The peace establishment of *personnel* and horses provides for four detachments only, which is sufficient for laying down and working a length of 40 miles of cable.

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The unit at war strength consists of the headquarters, to which one detachment is allotted, and four sections. This provides for laying and working a line 90 miles long.

The cable wagons are of the limber type, each carrying 8 miles of D. 14 cable. The limber boxes are fitted to carry the office sets and stationery, and 24 light poles for forming "crossings" are carried on the rear carriage. The light spring wagons carry kits, rations, and spare stores, including 2 miles of cable and a spare office set.

DIVISIONAL TELEGRAPH COMPANY.

There are for war seven of these companies. They are responsible for the internal telegraph communications of an infantry division. Each company is divided into three detachments. The working detachment consists of 1 cable wagon and 1 light wagon, 7 mounted and 6 dismounted N.C.O.'s and men, 4 riding horses, and 6 draught horses. A cable wagon carries 8 miles of cable and 2 third-class telegraph offices (vibrator sets), and the light wagon carries another 2 miles of cable and a third telegraph office, in addition to miscellaneous stores, food, and forage for the detachment.

In daylight, under ordinary circumstances, the rate of laying cable is from 3 to 5 miles an hour, but for short distances, on fairly straight roads on open country, the pace can be increased to the rate of 10 or 12 miles per hour. By night 2 miles an hour is a good average pace.

The cable is laid by pulling it off the drum by hand, but is picked up automatically by the drum being made to revolve by the wheels of the wagon.

Establishment of a Divisional Telegraph Company.

In	Officers.	N.C.O.'s and Men.	Horses.		Vehicles (Peace and War).	No.
			Riding.*	Draught		
Peace...	1	34	9	13	Cable wagons ...	3
War ...	2	57	21	20	Wagons, light, spring	3

* Includes officers' horses.

In peace only four of these units exist, one each with 1st (Aldershot), 3rd (Bulford), and 5th (Limerick) Infantry Divisions, and one in South Africa; the other three consist of a cadre only, viz., one sergeant, and have all their equipment in mobilization stores.

The composition of a divisional telegraph company is set out in detail in the *Manual for Field Service:—Engineers. Divisional Telegraph Company.* 1908.

(*To be continued*).

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TRAINING OF TERRITORIAL FIELD COMPANIES, R.E.

By MAJOR G. WALKER, R.E.

CAPT. BRUNNER'S article, in the July number of the *R.E. Journal*, has dealt with this subject on broad lines, and his remarks are generally just and true; but he appears to have overlooked a great deal of the preliminary work which is necessary to make an efficient field unit. His remarks will no doubt commend themselves entirely to most of the people concerned, as they deal alone with the interesting part of a Sapper's training, and leave out all the drudgery.

It is conceivable and pardonable in a man who gives practically the whole of his spare time to the King's Service, to desire that the work he does in that time should be such as to catch the public eye; but we Regular soldiers shall be failing very much in our fraternal duty towards the Territorial Force if we in any way deceive them, not only as to the end they should aim at, but also as to the means, no matter how minute, which our experience has taught us should be employed to gain that end.

The first thing that an officer of a Territorial Field Company, R.E., has to learn is military administration and internal economy. The care, feeding, and clothing of his men, the care and feeding of his animals, care of saddlery and equipment generally, are matters which possibly do not, at present, receive due attention. The next points are musketry and drill; and then we come to the combination of all the "home" teaching in march exercises—how in other words to get the unit from "here" to "over there."

The Territorial unit has in the past been accustomed to standing camps, with everything not only provided, but in fact most comfortably provided—large Officers' and Sergeants' Messes, with acetylene light, etc., and so forth. What they have to learn is to fend for themselves, unit by unit, without anybody's help. If these units are not mobile and thoroughly self-contained, they will never have an opportunity of thinking out or working out tactical problems with the other arms.

Having trained the officer, the N.C.O.'s and men come next. Their first lesson should be to realize the necessity for unquestioning loyalty and obedience to their superiors; they must then be taught to look after themselves, their animals, and equipment. Their civil trades will require little consideration, except that in organizing

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the company each section should have a due proportion of the useful trades.

Having now welded an aggregation of intelligent artizans into a self-contained and self-supporting military unit, and having taught it the rudiments of its military work, an advance may be made, and the object for which all this troublesome work has been undertaken—namely, the work of a Royal Engineer company in war—may be dealt with more particularly, although it should never have been lost sight of during the early teaching.

People seem to differ in their methods of expressing what the duties of the Corps are; but they may be summed up in the term "general usefulness." Engineers are an auxiliary arm; their duty is to help, and their knowledge and training should be such as to enable them to apply their technical knowledge to the solution of such military problems as may arise, both for other people and for themselves.

The skilful direction of the men's efforts must depend upon the knowledge of the officers of tactical methods, combined with engineering skill, as described in Capt. Brunner's article. In the latter also it is suggested that R.E. duties in connection with camps and communications are of minor importance "relatively." The reservation is a just one, but it seems a dangerous policy to label any work as minor: communications have been before now of dire importance.

As stated above, nothing should be slurred over. If these units are to be properly taught, they must be taught to work without considering the relative attractiveness or otherwise of the various subjects.

A word may be added regarding the formation of clubs. These institutions are most desirable in order to allow officers of different branches to interchange ideas and to learn to look at war from different points of view, and it is to be hoped therefore that funds may eventually be found for their provision in all the larger Territorial centres.

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TERRITORIALS OF EARLY ROMAN AND MEDIÆVAL TIMES.

By COLONEL O. E. RUCK, LATE R.E.

IN the August issue of the *R.E. Journal*, Colonel S. A. E. Hickson, D.S.O., R.E., contributes a valuable analogy with reference to the similarity of the Roman Republican constitutional methods instituted by Servius Tullius, Circa 440—400 B.C., by which the people, divided into centuries of their classes, gave their votes, to a somewhat similar system in vogue during Anglo-Saxon and up to mediæval times in this country.

It is claimed that effective and victorious national armies were raised under these systems, the chief influence in the national assemblies resting with those who, having an appreciable stake in the country, were patriotic, gave personal service, and, whilst being responsible, were invested with authority above their fellow citizens proportionately to the valuation of their estates.

Taking the quotations from Mommsen as authoritative, it may be helpful, by way of amplification, to refer to those of the early writers, from whose works some of Dr. Mommsen's erudite information may have been derived.

Turning to Varro, it would appear that conjointly with the *jus militiæ*, or the right of the early Roman citizen to take up arms in attack or defence of his country, there existed also the *jus tributorum*, or the right to pay for his own services, together with those of others; this contribution, or personal allowance, was exacted from every individual throughout the tribes called up for service, in due proportion to the Government valuation of his estate (*pro portione census*).[1]

There were three kinds of tribute :—

(A). One imposed equally on each person (*in capita*), which was the system under the first kings.[2]

(B). Another (*pro ratâ*) on the valuation of their estates, this being called (*ex censu*).[3]

(C). A third kind (extraordinary), demanded only in case of dire necessity (*temerarium*), therefore dependent on no fixed rules.[4]

[1] Varro de Ling., Lat., IV., 36. [2] Dionys., IV., 43. [3] Livy, I., 43, IV., 60; Dio., IV., 8, 19. [4] Festus.

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This latter kind (C) is reported in Livy, XXVI., 36, as being in many cases voluntary; but when bestowed, a note was made for future consideration that when the Treasury was again enriched, as indeed happened after the second Punic War, the loan might be repaid in full.

After the expulsion of the kings however, the poorer citizens were for some time freed from the burden of taxes until the year A.U.C. 349—B.C. 404, when the Senate decreed that pay should actually be given out by the Treasury to those of the poorer citizens who had hitherto served at their own expense, whereupon all ranks, rich and poor, high and low, were forced to contribute, according to their fortunes, for the pay, while serving, of themselves and their brother soldiery.[1]

This continuity of financial policy did not however endure much longer than a space of 230 years, for in Cicero, Offic. II., 22, we read that in A.U.C. 586—B.C. 167 annual tributes were generously remitted by reason of the immense sums reaped in by the Treasury, owing partly to the aggressive possessive strategy of L. Paullus Æmilius, after the defeat of Perseus, this immunity from taxation fortunately continuing, according to Plutarch, down to the consulship of Hirtius and Pansa.

Again, taking the second quotation from Mommsen as to the obligation of every freeholder for military service, it would appear from the fact of the early Romans being a nation of warriors, as a matter of course both by upbringing, precept, and example, every youth was bound to enter the military profession, the father of the aspirant being termed by Seneca "a domestic judge," by Suetonius "a censor of his son."[2]

Thus amongst the rights possessed by the early Roman citizen was also included the *jus patrum*, this privilege extending down even to the great-grandchildren; none of these descendants were their own masters until the death of their grandfathers.[3]

These being the prevailing conditions, it is not surprising for us to find that every citizen readily enlisted for service when his country required it. The age was fixed at this time at from 17 to 46 for the period of service, nor at first could anyone enjoy any official position in the city who had not served through 10 campaigns;[4] every foot soldier was obliged to serve 20 campaigns, every horse soldier 10.

At first, *i.e.*, in the days of the kings, none of the lowest class were enlisted, neither were freedmen, except in dangerous crises; but this was altered by Marius.[5]

[1] Livy, IV., 59, 60. [2] Sall., Cat., 39; Claud., 16. [3] Cic., de Legg., III., 8; Terence, Heant, IV., 1; Tacit., Hist., IV., 5; Senec., de Ben., III. [4] Polybius, VI., 17. [5] Livy, X., 21, XXII., 11, 57; Sallust, Jug., 86; Gellius, XVI., 10.

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Mommsen, referring to the early Republican constitutional methods of Servius Tullius, points out the changed conditions when every freedman, and even the emancipated slaves, had to serve; but it must be remembered that at this time the Romans were almost always engaged in wars, first with the different states of Italy during 500 years, and then about 200 more years in subduing and holding the various countries which composed their vast Imperial domain.

The number of recruits raised annually was an increasing quantity; in the early Republic times four legions, say 24,000 men, but often a greater number had to be found—ten, eighteen, twenty, twenty-one, twenty-three, under Tiberius twenty-five, even in time of peace, besides the Italians and the forces of the Allies, under Adrian thirty legions, a grand total of 180,000 men a year.[1]

In stating that every freeholder, from his 17th to his 60th year, was liable for service, it would appear that under the constitution of Servius Tullius, which Mommsen is alluding to, the first class, or the *classici*, who held the preponderating voting power in the assemblies, consisted of 80 centuries—40 centuries of young men (17 to 46 years old),[2] 40 centuries of elderly men (age not mentioned), called *seniorum*. The elders were guarders of the city, the youngsters were obliged to take the field (*ut foris bella gererent*). To these were added 18 centuries of *equites* or *celeres*,[3] a more mobile class, who fought on horseback, and were specially selected by Servius Tullius from the Chief Officers of State. Horse allowance of 10,000 pounds of brass (£322 18s. 4d.) was given for purchase of horses, whilst a tax was laid on windows for maintenance and upkeep of the said horses.[4]

Hence the origin of the great Equestrian order, which was of the greatest utility to the State as an intermediate bond between the patricians and plebeians.[5]

In the days of the emperors—time of Augustus, A.U.C. 763—A.D. 10—there appear to have been several causes for exemption from military service (*vacationes militiæ*). Of these the chief were :—

A. *Anno domine* or *ætas* (age), if over 50 years of age.[6]
B. Infirmity or disease (*morbus vel vitium*).[7]
C. Office (*honor*), being a magistrate or priest.[8]
D. Favour or indulgence (*beneficium*) granted by the Senate or people.[9]
E. Those who had served out their time, or *emeriti*.[10]

[1] Livy, II., 30, VII., 35, XXIV., 11, XX., 1, XXVIII., 38; Tacit., Annal., IV., 5; Spartian, 15; Pliny, III., 20, 24. [2] A. Gell., X., 28; Cic., de Sen., 17. [3] Varro et Festus, Livy, I., 30, 43. [4] Livy, I., 43, II., 1. [5] Livy. I., 43, II., 1. [6] Livy, XLII., 33, 34. [7] Suet., Aug., 24. [8] Plutarch in Camill. [9] Cic., Phil., V., 19; de Nat. D., II., 2; Livy, XXXIX., 19. [10] Livy, XXXVII., 4.

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Veteran soldiers who had served out their time were sometimes induced to re-enlist as bodyguards to exalted personages as *Evocati*.[1]

With regard to the obligation of emancipated slaves to serve, alluded to by Mommsen, it would appear that the same men who—*quâ* slaves—obtruded themselves into a levy raised upon a sudden alarm (*in tumultu*), and were liable thereby to capital punishment,[2] were, on coming into property, under obligation to serve.

This however appears to have been customary, not only in the Army, but also in the Navy,[3] where their services were utilized as mariners and rowers, a particular class of handy men whose professional attainments were not considered on a par, nor equally honourable, with those of the legionary soldier.[3]

To follow Colonel Hickson and Mommsen into the details of the most important feature of the article by the former in the August *Journal*, viz., the *Comitia Centuriata*, or constitution of Servius Tullius, and how it reacted most favourably on the power of the Roman arms in the future as time went on, necessitates a careful research into the early writers of these details.

Calculations as to the current values of the voting powers when reduced to their modern equivalent in British coin, at the then Government valuation rate, necessitates reducing asses and drachmæ to £ s. d.

Unfortunately the records do not give the total strength of the population at that time—Circa 400 B.C.—but only the number of those vested with the franchise on the register; but it is proposed to give, in a future article, a detailed description of this highly successful political constitution.

[1] Cic., Livy, XXXIV., 56, XLII., 22; Cæsar de Bell. G., VII., 1.
[2] Pliny, Ep. X., 38, 39. [3] Tacit., Annal., XV., 51; Suet., Livy, XXXII., 23, Aug., 16.

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THE FORM OF HELICOPTERS.

By LIEUT. E. ST. G. KIRKE, R.E.

ALTHOUGH the use of helicopters has not up to the present time come within the range of practical aeronautics, it is still of interest to consider the form of blade which may ultimately be expected to give the greatest lifting power, as soon as driving machinery has improved, power for weight. For the moment, heavier-than-air machines are limited in the sphere of their usefulness by the necessity of having a fairly level stretch of ground from which to rise, or upon which to alight, and in the latter case any miscalculation of speed or distance on the part of the aeronaut will result in damage to the aeroplane, as recently happened to that of M. Bleriot on arrival at Dover. Under active service conditions it may not always be possible to find ground suitable for manœuvring aeroplanes, and it is doubtful if they will vie with dirigibles as engines of war until vertical motion is possible.

Propellers, working in a fluid, depend for their function on the reaction caused by their projecting a mass of the fluid in the opposite direction to that in which the object they are propelling is intended to travel, and their power is proportionate to the mass and velocity of the fluid which they project. The efficiency of the ordinary screw propeller varies considerably according to the amount of its *linear* velocity, as well as to the velocity of rotation, and the propeller which will give very satisfactory results in a ship travelling at 20 knots an hour may be most inefficient in another travelling at ten, although driven by the same engines and at exactly the same number of revolutions. The reason for this is that the resultant of the linear and rotary velocities completely alters the obliquity of the blades relative to the water in which they are working. Again, two similarly engined ships may form entirely different wakes, even when travelling at the same speed, and this factor has considerable bearing on screw efficiency.

The propeller which projects its stream of water astern with as little shock as possible is obviously the best, and the form of blade most calculated to fulfil this condition will be the most efficient.

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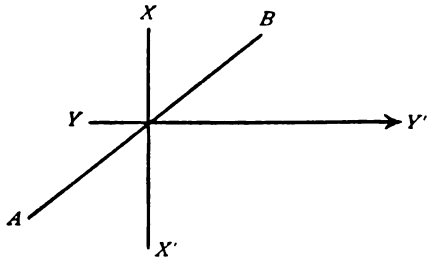
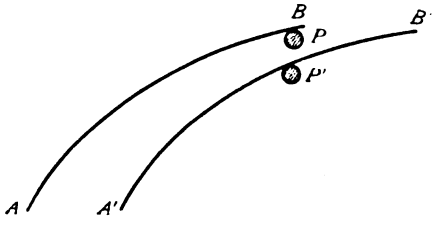
A plane AB moving through a liquid with a given velocity in the direction YY′ will force the liquid in the direction XX′ if friction is



not taken into account, but there must be considerable shock as the plane strikes each particle of water prior to imparting velocity. To eliminate this shock the leading edge of the plane must be parallel to the direction of motion, that is to YY′, and the blade as a whole must be curved in such a way that the fluid has velocity impressed upon it with a constant acceleration in the direction XX′.

The curve of the blade necessary to ensure this result can be arrived at as follows :—A propeller AB travels in one second to the



position A′B′, thereby moving the particle P to P′, supposing friction to be non-existent. At the end of this second the particle will have had impressed upon it a velocity V. Taking the acceleration, which has caused this velocity, to be unity, the velocity will itself be unity, and the shape of the blade must be such that during each successive second of motion a unit of velocity will be added to the particle.

The form of blade is therefore easily evolved from the formula

$$v = u + ft.$$

An experimental propeller of the above form, working under ideal

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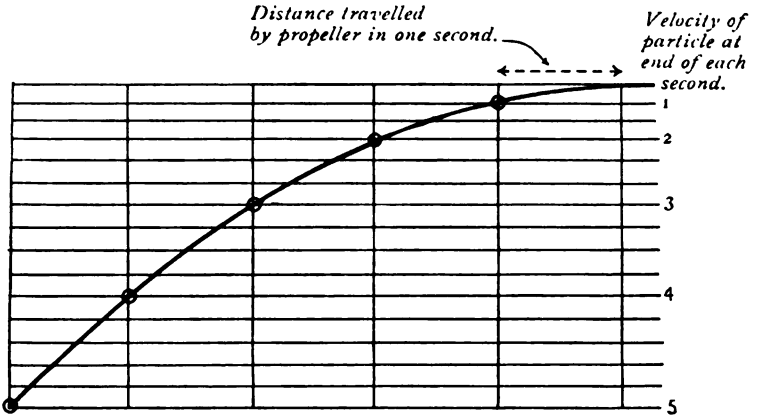
conditions (*i.e.*, without any *linear* velocity), has exerted against a spring recorder a pull five times as great as that of an ordinary Admiralty pattern propeller, turning at the same number of revolutions.



Moreover the direction of the flow of water is altogether different. The ordinary propeller takes water along a line parallel to the axis of its shaft (*Fig.* 1).

A propeller of the form shown in the diagram takes water in a direction normal to the axis of its shaft, as indicated by the arrows (*Fig.* 2).

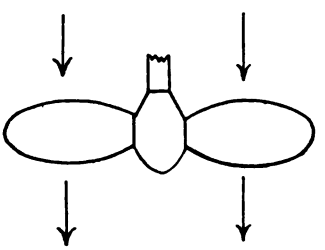


FIG. 1.

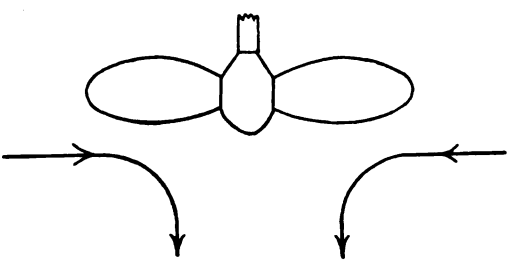


FIG. 2.

It is difficult to say whether any advantage will accrue from this phenomenon as regards aeroplanes, but it would certainly seem possible to use helicopters of the above form under the gas-holder of a dirigible, enabling its elevation to be controlled, even when stationary, otherwise than by adjustments of ballast or gas. For

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instance, helicopters could be arranged to hold down a dirigible without any extraneous assistance while its gas-holder was being inflated, and heights, which are now impossible, could be attained without the sacrifice of a certain amount of fuel entailing reduced radius of action. It is to be seriously considered whether the size of gas-holders could not be very much reduced by applying the motive power of a dirigible to assist vertical movement when it is not required for purposes of propulsion, in combination with elevating planes to maintain the dirigible at heights reached with the aid of helicopters, when horizontal travelling is contemplated.

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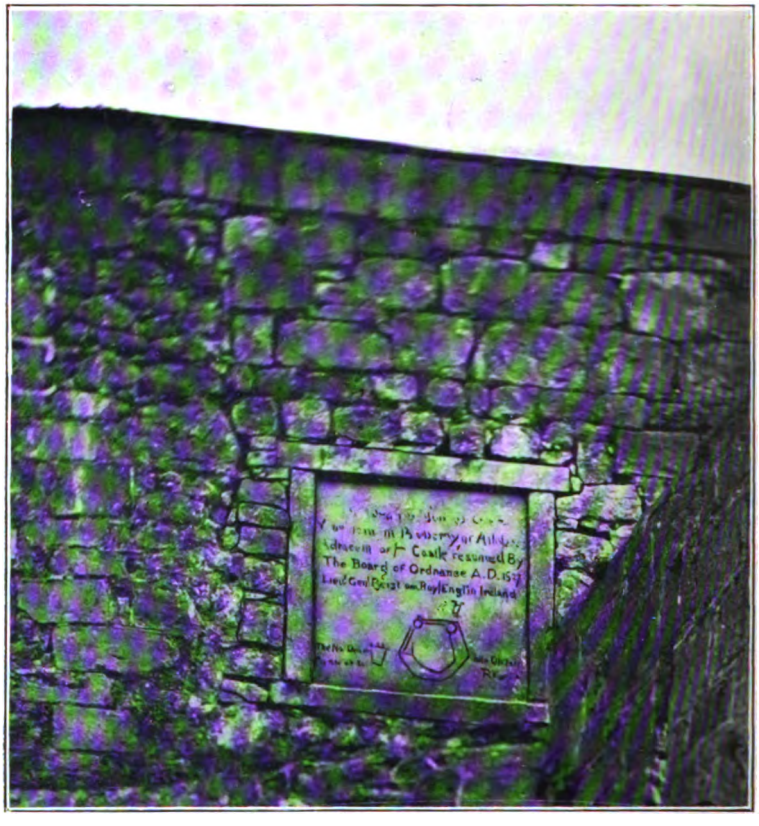

Stone, in Escarp Wall at Athlone, showing Incised Plan of Castle.

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THE FYERS FAMILY.

(*Continued*).

By Col. Robt. H. Vetch, c.b., late R.E.

Lieut.-General William Fyers, Colonel Commandant, R.E.

(*Continued*).

During his long stay at Gibraltar, Fyers, on the whole, had found his life a pleasant one. Improvements and alterations both in fortifications and barracks gave him plenty of work to supervise, and his house was a social centre. His young family had grown up about him. Three of his charming daughters, who assisted Mrs. Fyers to dispense the hospitality of the Commanding Royal Engineer's house, had been happily married. His eldest son, Thomas, already in the Corps, had come out to Gibraltar to serve under him, and his younger son, Edward, was at Woolwich hoping to get Sappers. He had been able during his sojourn at the Rock to revive old friendships with comrades who had served with him in the American War of Independence, and to form new ones with the younger generation of the Services who came to do duty for a time at the fortress, or stayed there on their way to and from Corsica, Malta, or Egypt. He had taken the greatest interest in the welfare of the garrison. The magnificent Garrison Library which he founded, and spared no pains to develop and improve, is a lasting memorial of one phase of this interest. His long labours in connection with it were heartily recognized by his brother officers, who in 1790 caused his portrait to be painted and hung in the Library, where it still remains. A reproduction of this portrait appears in Porter's *History of the Corps of Royal Engineers*. Colonel Fyers had enjoyed exceptionally good health at Gibraltar in spite of several epidemics of disease in the garrison during the years he had been there, but at length, in the beginning of 1807, his health broke down, and he was seriously ill for several months. The doctors ordered him home as soon as he was able to travel, and he arrived in England in May of that year.

After only two months' leave of absence, Colonel Fyers was again ready for work. In July he was made a member of the Committee at the Tower. This Committee was originally instituted in 1782. Four officers of Royal Engineers were then appointed to assist the Chief Engineer of Great Britain as a board of reference, whose duty

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it was to report upon all plans and estimates submitted to it. The members of the Committee had no other duties to perform. In 1802 the Royal Warrant of 21st April, which changed the title of Chief Engineer of Great Britain into that of Inspector-General of Fortifications, also abolished the permanent Committee at the Tower. The duties were transferred to the new Inspector-General of Fortifications, Lieut.-General Robert Morse, who was permitted, when expedient, to nominate an unpaid Committee to examine and report to him upon projects, plans, and estimates submitted to it. Such a committee was formed shortly after (in 1803), composed of officers holding other appointments, for which they drew their pay. The nomination of Colonel William Fyers to this Committee was no doubt in anticipation of his undertaking the duties of Deputy Inspector-General of Fortifications, a new office which was to come into being on the 31st August, 1807.

Major-General Whitworth Porter, in his *History of the Corps of Royal Engineers*, seems to think that the Committee at the Tower, as it was called, was abolished at this time, but this is an error. Colonel W. Fyers continued to serve on the Committee while he was Deputy Inspector-General of Fortifications, and his son-in-law, Major-General Cornelius Mann, was a member of it from 1814 to 1830, during the time he was holding staff appointments at the Board of Ordnance. I have traced records of meetings of the Committee down to 1835.

In his post at the Board of Ordnance Fyers found himself very fully occupied, and in close touch with his old chief at Gibraltar, General Robert Morse, who knew his value, and with whom he worked most cordially. Fyers was also in frequent communication with the Master-General of the Ordnance, John, Earl of Chatham, who had entered on office the same year that Fyers was appointed Deputy Inspector-General of Fortifications. Fyers had known him in America, and also at Gibraltar. When therefore a chance of again going on active service occurred, his previous war services were not forgotten, and with both the Master-General of the Ordnance and his own chief to recommend him, he was fortunate enough to be again employed in war service. Whether he had forgotten the advice of his old friend, General O'Hara, at Gibraltar, when he was anxious to volunteer for Toulon, or whether he considered that with his youngest child already 10 years old the advice did not hold good, or that he was ordered to go without being consulted, in any case he was appointed the Commanding Royal Engineer of a very formidable expedition.

In 1809 Napoleon Buonaparte had succeeded in establishing extensive dockyards and arsenals at Antwerp, Terneuse, and Flushing. From these he had already launched and fitted out a powerful fleet, which lay in the Scheldt fully manned and ready for immediate

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service. Other ships were on the stocks, and a vast quantity of timber and stores of all sorts had been collected. These establishments, together with the fleet, were always protected by a large land force, and were the subject of serious apprehension to England. But when Napoleon invaded Austria in 1809, after the retreat of the British in the north of Spain, under Sir John Moore, he ventured to withdraw his troops from the Low Countries to swell his invading army. The British Government deemed the opportunity a favourable one to destroy the establishments that had been built by the labour of many years and the expenditure of many millions, and as soon as Napoleon was occupied in operations across the Rhine, an expedition was organized with the object: of capturing or destroying the enemy's ships either building at Antwerp or Flushing, or afloat on the Scheldt; of destroying the arsenals and dockyards at Antwerp, Terneuse, and Flushing; of reducing the island of Walcheren; and, if possible, of rendering the Scheldt unnavigable for ships of war.

A joint naval and military expedition was organized on a very large scale. The fleet, commanded by Rear-Admiral Sir Richard Strachan, comprised no less than 37 sail of the line, two 50-gun ships, three 44-gun ships, 23 frigates, and 180 sloops, gunboats, bomb vessels, etc., altogether 245 war vessels, accompanied by 400 transports.

It is perhaps easier to realize what an imposing fleet this was if we recall the review by the King of the fleet at Spithead on 31st July last, when the 1st-class battleships and cruisers numbered 38, the 2nd-class battleships and cruisers 34, other cruisers 29, and gunboats, scouts, destroyers, etc., 143, altogether 244 war vessels.

The land force, 40,000 strong, was commanded by the Earl of Chatham. To this force Colonel Fyers was appointed Commanding Royal Engineer. He had under his orders with the several divisions of the Army the following officers of the Corps:—Lieut.-Colonels D'Arcy and Pilkington, Capts. Rudyard, Birch, Squire, Pasley, Fanshawe, Macleod, Boteler, and J. T. Jones (who acted as Brigade-Major), Lieuts. Calder, Lascelles, Cardew, Hutchinson, Ross, Brown, Harry Jones, Rawlinson, Bonnycastle, Trench, Colby, Longley, Power, McDonald, Dickenson (Adjutant), and Wells (Adjutant), with Meinecke, of the King's German Legion.

The enormous fleet of ships of war and transports sailed from the Downs on the 28th July. Landings were effected on the 30th to reduce the island of Walcheren, Middelburg was occupied, and Veere surrendered on the 1st August, its garrison becoming prisoners of war. The same day the British troops were put in movement for the investment of Flushing, Lord Chatham fixing his headquarters at Middelburg.

Much of the ground around Flushing was liable to inundation, and regular siege approaches were impracticable. It was decided by Colonel Fyers's advice to try the effect of bombardment in order to

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induce a capitulation. Colonel Fyers recommended that batteries should be constructed on detached points which happened to be above the ordinary level, and also on the dykes themselves, and that these batteries should be connected by a trench, which should follow the highest levels available. First however it was necessary to reduce Fort Rammekins, already blockaded by Lieut.-General Frazer's division, because it commanded the Sloe Channel separating Walcheren from South Beveland, by which alone the transports then at anchor off Veere could enter the Western Scheldt. Colonel Fyers judged that the Commandant of Fort Rammekins would surrender on bombardment, and selected a spot for a gun and mortar battery to be begun at dusk on the 2nd August. The next day the garrison directed a good deal of fire on the battery in progress, till the 95th Rifle Corps was pushed forward close to the ramparts wherever cover could be found, and fired at such of the garrison as showed themselves above the parapet, or at the embrasures, till they had silenced the fire of the fort. On the afternoon of the 3rd, when the battery was nearly ready, the garrison of Fort Rammekins, numbering 127 men, surrendered themselves prisoners of war. Thus the Sloe Channel was open, and in the meantime Sir John Hope had obtained possession of every part of South Beveland, the Dutch General, Bruce, having retired with his troops, some 500 men, to Bergen-op-Zoom.

The besieging force before Flushing mustered altogether 17,000 men, consisting of the divisions of Lord Paget, Lieut.-General Graham, Lieut.-General Grosvenor, Lieut.-General Frazer, and a reserve under Brigadier-General Houston. On the night of the 3rd August the construction of siege batteries began. Bad weather hindered the work and also, in conjunction with the intricacies of the navigation, delayed the sea blockade, which was not effectually established until the 6th August, so that in the interval the French were able to ferry over 2,000 men and augment the garrison to 5,000 effectives. A strong sortie, under General Monnet, the Governor, was made with great spirit on Lieut.-General Graham's division on the afternoon of the 7th; but it was repulsed, our loss being 13 men killed, and 8 officers and 126 men wounded. The connection of the siege batteries by a trench, or parallel, was a difficult matter, the trench having to follow the higher levels and yet be free of enfilade fire, and it therefore assumed a very meandering line. In consequence of the increased numbers of the Flushing garrison, Colonel Fyers proposed to augment very considerably the works of the attack. He enlarged the battery on the Knolle Dyke (No. 5) to contain 12 24-prs., 6 mortars, and 2 howitzers, and Battery No. 2 to contain 4 heavy mortars. On the morning of the 9th the Naval flotilla effected the investment of Flushing, on the sea side. The following day the garrison partially opened the sluices, so far as greatly to incommode the besiegers without laying the whole country under water.

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On the morning of the 13th August the batteries opened fire. The same night an advanced *flèche* on the right, in advance of the demi-bastion, was stormed, and carried by a detachment under Lieut.-Colonel Nicholson. He captured a gun and brought off 30 prisoners, with the loss of 8 killed and wounded. Colonel Fyers, who was present and making observations through his glass, was struck on the chest by a musket ball fired by a picquet posted in Old Flushing, not 100 yards away. Fortunately the bullet grazed the parapet before striking him, or he would have been killed.

The following day Sir Richard Strahan, with seven line-of-battle ships, stood up the Scheldt and joined in the bombardment. The general bombardment continued till 4 p.m., when the artillery of the place was silenced, and the town was blazing furiously. At night it was ascertained that the garrison in desperation was cutting the eastern dyke to let in the sea. To stop this menacing work was imperative at any cost, or the whole of the British trenches and batteries, except those on the dyke, would have been inundated to 4′ or 5′ of depth. A large storming party, under Lieut.-Colonel Pack, was detailed to assault the advanced works on the eastern side. This was successfully accomplished. Many of the defenders were killed and 40 prisoners taken, but 5 officers and 30 men were the British casualties. Capt. Pasley, R.E. (afterwards General Sir C. W. Pasley, K.C.B.), greatly distinguished himself on the occasion when leading the storming party which carried one of the works. Having received a musket ball through his body and a bayonet stab in his thigh, he nevertheless stuck one Frenchman, disarmed a second, stabbed a third, and was attacking a fourth when he fell. On the following day General Monnet capitulated, and on the 18th the garrison marched out over 5,000 strong, and laid down their arms as prisoners of war.

Colonel Fyers in spite of his wound insisted on all Engineer reports being rendered to him, and the next senior officer of Engineers was very nearly tried by court-martial for raising an objection. It is only necessary to refer very briefly to the remainder of the campaign. A week later Lord Chatham's force, concentrated at Bathz and protected by the fleet, was ready to disembark on the Continent and lay siege to Antwerp. But a change had come over the scene. The French had recovered from their surprise, had collected an army of 25,000 men round Antwerp, and had flooded the country. The great chance had gone, and a campaign which began with so much promise ended in fiasco. The reduction of Flushing virtually ended the campaign. A council of war was held on the 27th August, at which it was decided to abandon any attempt on Antwerp. The force fell back on Walcheren.

On the 17th August Lord Chatham had asked Colonel Fyers to prepare plans and submit to him his proposals for assuring the

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security of the island of Walcheren. Fyers considered that the basis of defence for Flushing laid down by Napoleon in his decree of 26th March, 1808, held good for the English. This was that the defence of Flushing rests on inundations, and that when an enemy appears the dykes must be cut and the island laid under water; but as an enemy can approach the dykes, a point on each dyke must be occupied, so that no enemy can get within range of the fortress. Fyers desired so far to modify the drastic treatment approved by Napoleon as to limit the inundation to what was absolutely necessary to secure Flushing from attack without overwhelming the island. He therefore proposed to finish the works on the dykes already begun, and by means of an interior counter-dyke passing across the peninsula in front of Flushing, with its extremities resting on the new forts, to confine the inundation to a radius of 2,200 yards from the ramparts. He proposed to feed this inundation by large sluices under the protection of the Flushing defences, so that should an enemy cut the interior counter-dyke, such a flow of water might be maintained over the ground between the town and dyke as would prevent him carrying his approaches over it. On account of its great cost, the proposal could not be authorized until it was decided whether the Government would permanently retain possession of Walcheren Island, and in the meantime Fyers employed the peasantry in strengthening the existing defences of Flushing, Rammekins, and Veere. Lord Chatham arranged to leave nearly 17,000 men to garrison Walcheren, and on the 14th September embarked the remainder of the army for England, Fyers accompanying him.

Colonel Fyers resumed his duties as Deputy Inspector-General of Fortifications on his return from the campaign, and when the terrible sickness decimated the British troops at Walcheren, until their effective strength was reduced to 4,000 men, and it was decided to evacuate the island, Lieut.-Colonel Pilkington carried out the destruction of the defences, and of the basin and breakwater at Flushing, which had been ordered.

Fyers was promoted to be Major-General on the 4th June, 1811, but he continued to hold his appointment at the Board of Ordnance until Colonel Rowley relieved him six months later. He was then given the Engineer Command in Ireland. It is a curious coincidence that Fyers's service in Ireland, which lasted until his death, was as nearly as possible the same length as his service at Gibraltar, viz., 18 years. He seems to have been as popular a chief in Dublin as he was at the Rock. There are however no details of his service in Ireland available. His son, Capt. Edward Fyers, R.E., was his Aide-de-Camp in Ireland in 1812 and 1813, and again for a short time in 1816.

When the order was issued at the end of 1814, removing from the strength of the Corps all general officers who were not Colonels

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Commandant, a great compliment was paid to Major-General Fyers. He was offered the choice either of retaining the Engineer Command in Ireland without receiving the pay of a general officer, or of accepting the new rule. Fyers had no hesitation as to his choice. He did not feel at the age of 61 years at all inclined to go on the shelf. So long as he could continue the life he was leading he was quite indifferent to the loss of pay. So he replied in the following terms :—

"It is my choice and the wish of my heart to serve His Majesty in the Corps to which my genius and inclination led me in early youth, and in which I have used my best exertions for 42 years with unremitting anxiety of mind, frequently before His Majesty's enemies, and I trust never with discredit."

Fyers became a Colonel Commandant of the Corps on the 11th November, 1816, and on the 12th August, 1819, was promoted to be Lieut.-General. He seems to have preserved his energy and capacity for work until the end, for he died in harness, after an illness of only two days, on the 27th October, 1829, in the 77th year of his age.

He was very much respected in Dublin, and his own officers were particularly attached to him. He was buried in Christ Church Cathedral. His brother officers who served under him erected in the Cathedral a tablet of white marble edged with black, on which was inscribed the following epitaph :—

TO THE MEMORY
of
LIEUT.-GENERAL WILLIAM FYERS,
COLONEL COMMANDANT,
AND COMMANDING ROYAL ENGINEER IN IRELAND,
Who died October 27th, 1829, aged 77 years,
And was here buried.
This tablet is erected by the officers
Who served under the Lieutenant-General,
In testimony of their sincere respect and esteem.

By the kindness of the Commanding Royal Engineer at Belfast, I am able to refer to a curious memorial of the General's command in Ireland which exists at Athlone. It is an incised plan of the castle on a stone let into the escarp. Colonel St. John has sent me a copy of the inscription and plan (given below), and a photograph showing its position, which is also reproduced.

I have already mentioned that the daughters of Thomas Fyers, Overseer of the King's Works in Scotland, were all married, but special reference was only made to Alexandrina, the third daughter, who married the Rev. James Reid, and became the mother of Lieut.-General Sir William Reid. Another daughter, and she the eldest, should

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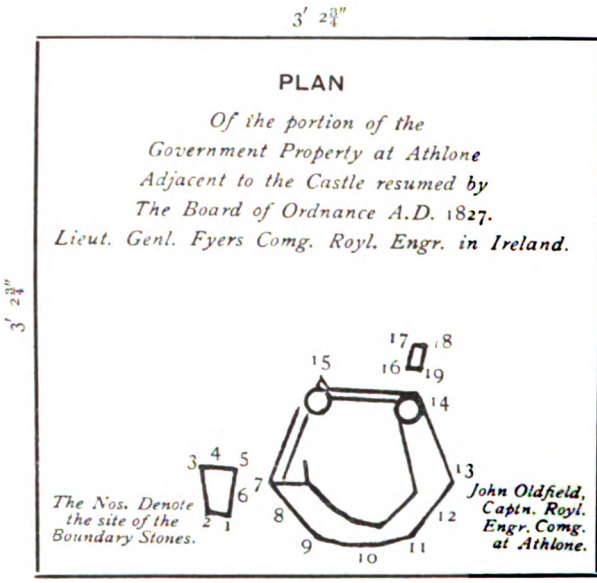
3′ 2¾″
3′ 2¾″
PLAN
Of the portion of the
Government Property at Athlone
Adjacent to the Castle resumed by
The Board of Ordnance A.D. 1827.
Lieut. Genl. Fyers Comg. Royl. Engr. in Ireland.
The Nos. Denote the site of the Boundary Stones.
John Oldfield, Captn. Royl. Engr. Comg. at Athlone.

have had some notice. Elizabeth Fyers was born at Inverness on the 13th October, 1751. She married George Peter, Esq., of Chappel, Selkirkshire, and died young, leaving three children, a boy and two girls, who were brought up by their grandmother, old Mrs. Fyers, in Edinburgh. None of these children married. The eldest, George Peter, got a commission in the 59th Foot. He was for some time Captain and Adjutant of his regiment, and it is stated that he rose to the rank of Colonel, but this I have not been able to trace.

The children of Thomas Fyers that have received some sort of notice in this paper are in order of seniority :—Elizabeth (Mrs. Peter); William Fyers, Lieut.-General and Colonel Commandant, R.E.; Alexandrina (Mrs. Reid); Thomas Fyers, Treasurer of Malta; and Peter Fyers, Major-General and Colonel Commandant, R.A.

The other daughters were :—Anne, married to James Thomson, of Leith; Mary, married to the Rev. D. Mackenzie, of Fodarty, Ross; and Margaret, married to W. Kerr, of Leith, but of their families I have no information.

My main design in writing this paper was to give a memoir of Lieut.-General William Fyers, Colonel Commandant, R.E., and incidentally to show how large a number of officers of the Services have descended from his father, Thomas Fyers, Overseer of the King's Works in Scotland.

The first purpose has now been achieved, however imperfectly. I propose next to deal with the other object in view.

(To be continued).

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THE USE OF LARGE GAS ENGINES FOR GENERATING ELECTRIC POWER.

Abstracted from the Proceedings of the Institution of Electrical Engineers by CAPT. A. E. DAVIDSON, R.E., *with the kind permission of the Council of the Institution.*

THE following article on the use of large gas engines for generating electric power is practically an abstract of a lecture given on the above subject by Messrs. L. Andrews and R. Porter, and also of the points brought out at the subsequent discussion. The question is at the present moment one of vital importance to engineers, as was evidenced by the record audiences which crowded the Lecture Theatre of the Institute of Civil Engineers to its utmost capacity, both when the paper was read and also at the subsequent discussion.

Hitherto the use of large gas engines has been chiefly confined to iron and steel works, where they are run, on blast furnace and other waste gases, for driving blowing engines and generating electric power.

In Germany, however, the manufacture of large gas engines is an established industry on a large scale, and whilst for some years there have been a few blast furnace gas-engine installations working in this country, the engines used have been mainly limited to capacities of from 300 to 500 B.H.P. Credit must undoubtedly be given therefore to the German iron and steel industry for having created the demand which has brought the large gas engine to its present state of perfection.

The use also of large gas engines for driving electric generators is a subject which is receiving considerable attention in the United States, where a special committee has reported upon it.

Whilst the authors believe that there is an important field for the use of large gas engines for driving electric generators, they do not consider that there is justification at present for the suggestion that has been made, that the internal combustion engine will in the early future be used to the exclusion of the external combustion engine.

The position, as far as present knowledge goes, may be briefly summarized as follows :—

I. The internal combustion engine is very much more economical than any external combustion engine yet known.

II. The capital cost of a gas-engine and producer installation is greater than that of a steam-turbine and boiler installation of equivalent overload capacity.

III. There is no material difference in the reliability or in the cost of labour, stores, and repairs of the respective systems.

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In cases therefore, where the cost of fuel is low and the load factor is low, it will generally be a mistake to use gas engines. On the other hand, where the load factor is high or the cost of fuel is high, there can be no doubt that gas engines will prove to be by far the cheapest prime mover to employ for driving electric generators. The majority of cases to be dealt with will doubtless fall between these two extremes.

As it is difficult for engineers to utilize the available knowledge upon the subject to the best advantage, the authors have endeavoured to collect the facts from a large number of different sources, and to apply the information obtained to a hypothetical scheme, as nearly comparable as possible with existing power supply schemes now being carried out.

In the first scheme to be considered, the estimated maximum load to be dealt with is estimated at 8,000 k.w., and it is assumed :—

(1). That the overload and stand-by capacity of the plant shall be such as to carry the maximum load of 8,000 k.w. for at least two hours, should any portion of the plant break down at the time when one unit is already laid off for overhaul.

(2). That the power generated is utilized for public and private lighting, and for a tramway and general industrial motor load; that the load factor—*i.e.*, $\frac{\text{units sold} \times 100}{\text{maximum demand} \times 8760}$, equals 24 per cent. and that the efficiency of distribution—*i.e.*, $\frac{\text{units sold} \times 100}{\text{units generated}}$, equals 80 per cent., and that the mean daily load curve is approximately of the shape shown in B, *Fig.* 1.

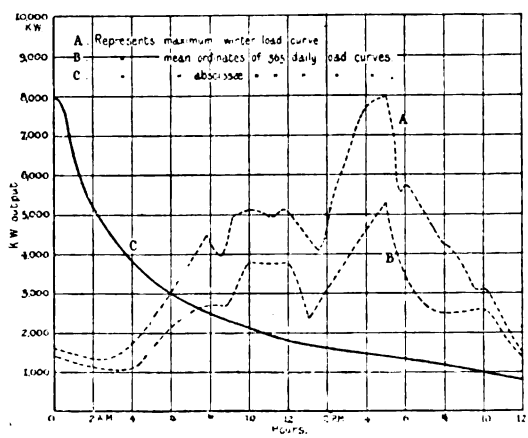

FIG. 1.

NOTE.—Curves A and B are the usual daily load curves. Curve C shows the number of hours in a day during which a given load is maintained.

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(3). That the cost of good bituminous slack, having a calorific value of 13,000 B.Th.U.'s per lb., is 12s. per ton, delivered at the generating station.

Choice of Site.—The points to be considered in selecting a site for a gas-driven station are practically the same as for a steam-driven station, viz. :—

A.—A plentiful supply of water for cooling purposes.
B.—Transport of fuel.
C.—Suitability of site relatively to position of centre of distributing area, as affecting the cost of feeders.
D.—Liability of nuisance to adjoining property.
E.—Cheapness of land.
F.—Cost of constructing foundations for plant, buildings, and chimneys.

In choosing a site for a steam-turbine station, it is often good policy to sacrifice other advantages in order to get a site with a plentiful supply of cold water for condensing purposes. This advantage has usually, however, to be heavily paid for. It is consequently often very much cheaper, on the whole, to put down cooling towers for condensing purposes.

A convenient lay-out for the steam plant is shown in *Figs.* 2 and 3. *Figs.* 4 and 5 show a convenient lay-out for the gas plant.

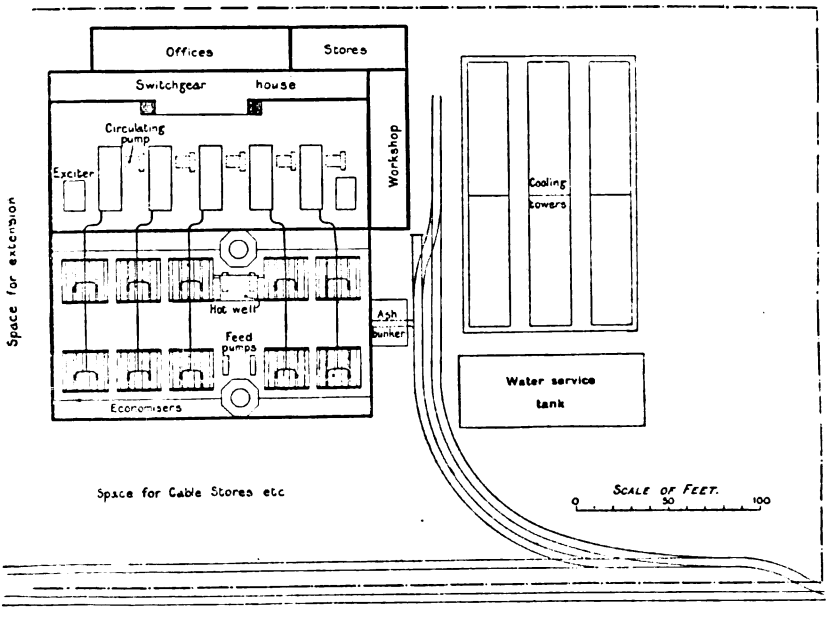

FIG. 2.—10,000-*k.w. Steam Plant* (*Plan*).

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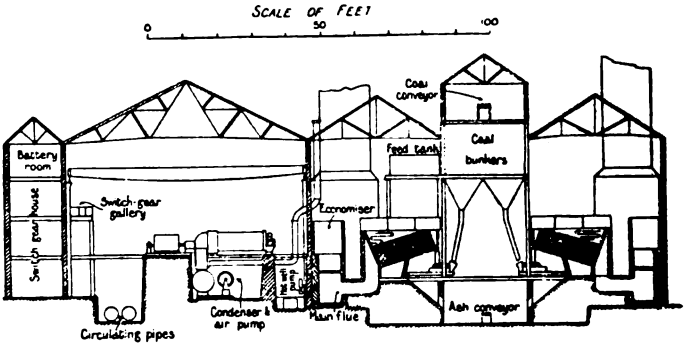

FIG. 3.—10,000-*k.w. Steam Plant* (*Elevation*).

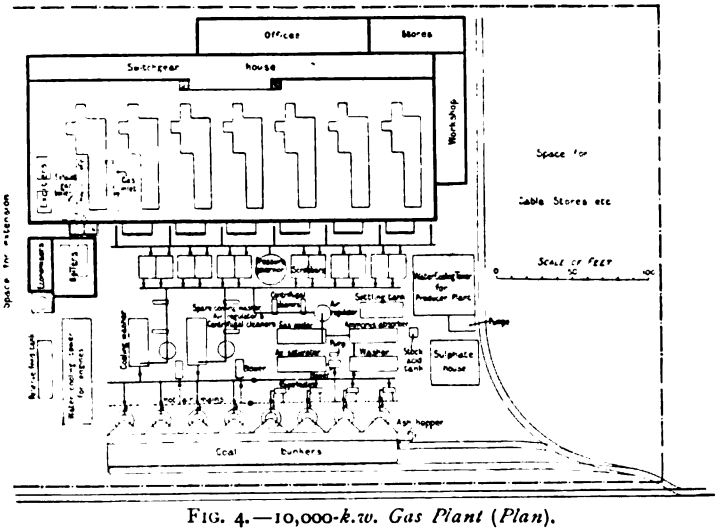

FIG. 4.—10,000-*k.w. Gas Plant* (*Plan*).

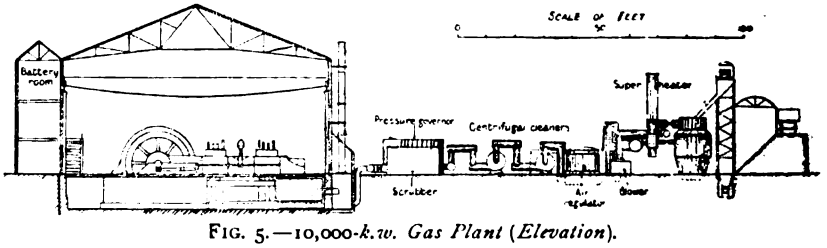

FIG. 5.—10,000-*k.w. Gas Plant* (*Elevation*).

Type of Generating Plant.—For the *steam plant* the authors assume turbines of horizontal type, each exhausting into a separate surface condenser placed directly below. Natural draught cooling towers, circulating water obtained from town supply. For the *gas plant* engines of slow speed, 4-cycle, double-acting tandem type, directly coupled to overhanging flywheel 3-phase generators. Cooling water for engines treated in the same manner as in the case of the steam plant.

Capacity of Generator Units.—Experience has shown that large units in steam plant are considerably more economical both in first

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cost and running cost than small units, and so units giving an overload capacity of 8,000 k.w. might be installed.

To comply however with the suggested specification as to overload capacity, it appears that the most economical arrangement of units would be five plants, each having a normal capacity of 2,000 k.w., with an overload capacity for two hours of $33\frac{1}{3}$ per cent.

The output of gas-engine units is at present limited to about 1,500-B.H.P. per cylinder. Four such cylinders arranged in twin tandem would give a combined output of, say, 4,000 k.w. But as the overload capacity of gas engines is only some 10 or 12 per cent., seven generators, normal capacity 1,450 k.w., overload capacity 1,600 k.w., would appear to be an economical installation.

Single Tandem versus Twin Tandem Combinations.—The next point to be determined is whether the engines shall be of the single tandem or twin tandem type. The only advantage of the twin tandem over the single tandem combination appears to be that, with a 4-cycle engine, the crank shaft will receive four impulses instead of two. It is obvious therefore that, with a given flywheel effect, the cyclic irregularity will be considerably greater with the latter than with the former.

Fig. 6 shows the cyclic variation for four types of engines, and *Fig.* 7 the comparative flywheel effect necessary to ensure a cyclic irregularity not exceeding 1/250, this being the maximum variation under which generator makers usually guarantee satisfactory parallel running. *Fig.* 8 shows the relative costs of the two types.

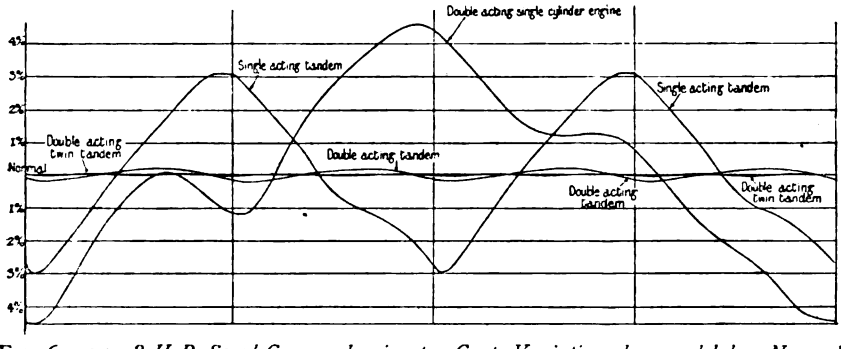

FIG. 6.—750-*B.H.P. Speed Curves showing per Cent. Variation above and below Normal when fitted with a Flywheel constructed for a Tandem Double-Acting Engine having a speed variation of* 1/250.

Double-acting twin tandem	0·02 per cent.
Double-acting single tandem	0·2 ,,
Single-acting tandem	3·1 ,,
Double-acting single cylinder...	4·5 ,,

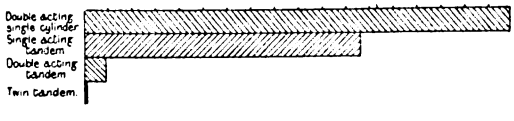

FIG. 7.—*The Flywheel Effect necessary to ensure Cyclic Irregularity not exceeding* 1/250.

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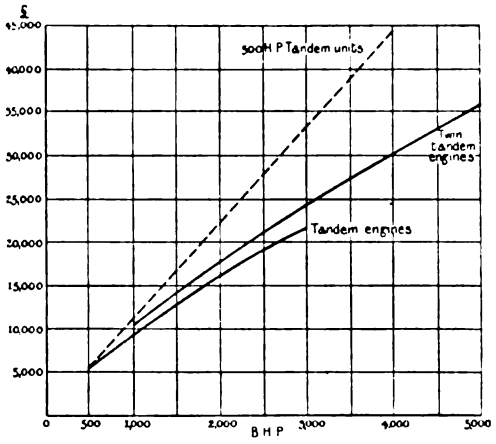

FIG. 8.—*Capital Costs of Slow-Speed Horizontal Gas Engines.*

It appears that for the conditions under discussion the single tandem engine is the best type of plant for the purpose.

Boilers.—Water-tube boilers with self-contained superheaters and automatic stokers have been selected. On the basis of 20 lbs. steam per unit generated, four 10,000-lb. boilers have been put down for each 2,000-k.w. turbine.

An economizer has been provided for each boiler.

Producers are to be found working in this country in an entirely satisfactory manner with bituminous coal in conjunction with large gas engines. With properly designed engines there appear to be no greater difficulties to contend with than when working on blast furnace gas. The comparatively high percentage of hydrogen requires a lower compression in the engine. Difficulties were experienced in the earlier days in the removal of tar, dust, and other impurities, but they appear to have been overcome by efficient cleaning appliances.

Difficulties arising from variations in the quality of the gas—caused by charging or clinkering the producers—practically disappear when a number of producers are connected together to feed into a common main or common receiver, where the gases from the various producers are mixed together, and the effect of any variation in the quality of the gas from individual producers is thereby neutralized. To derive the full benefit of this feature the producer plant should not be divided into units corresponding to the generator units, as has been recommended for steam boilers.

Sulphate of Ammonia Recovery Plants.—A very important point to be considered in designing a gas-engine station is that of providing for the recovery of sulphate of ammonia.

There are numbers of recovery plants that have been working for some years, where the sale of the by-product has almost equalled the cost of the fuel used. Results obtained have been so entirely satisfactory that one is at first sight tempted to think it must pay to provide

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for sulphate of ammonia recovery in every instance. There are however many expenses incidental to the recovery of sulphate of ammonia in addition to the fuel.

The following points must be taken into consideration as affecting the use of ammonia recovery plants :—

1. The first cost of the recovery plant, particularly for small sizes, is very much greater than the first cost of non-recovery plant.
2. Considerable extra labour is involved in operating the plant.
3. The purchase of sulphuric acid, of which approximately 1 ton is required for every ton of sulphate of ammonia turned out, is quite a heavy item.
4. The yield of heat units per ton of coal is slightly less if sulphate of ammonia is recovered than the yield from non-recovery plants.
5. The extra cost of repairs and the cost of handling and packing the by-product absorb some of the profits effected by the recovery process.

Experience, up to the present, appears to indicate that it is not worth while to attempt to recover sulphate of ammonia unless the total output of the plant is greater than 2,000-H.P., and then only on an exceedingly good load factor.

For a maximum output of 8,000 k.w. it would probably pay to put down ammonia recovery plant, even for so poor a load factor as 24 per cent. An even more profitable arrangement however would be to provide for ammonia recovery on one portion of the plant, which could be kept working at a very high load factor almost continuously, and to use non-recovery plant for dealing with the peak load and remaining portion of the total output.

Buildings and Foundations.—The cost of the engine room and engine foundations for the gas-driven plant is of course considerably greater than that of the steam plant, but practically no buildings are required for the producers. The total cost of buildings amounts to considerably less therefore for the gas station than for the steam station.

Exciting Plant, Switchgear, etc.—It has been assumed that for both the steam plant and the gas plant the field circuits of the generators would be excited from busbars fed by two steam-driven exciters, each capable of generating the whole of the exciting current required on full load. The exciters would be supplemented by a battery capable of maintaining the full field current required for a period of 24 hours.

The switchgear would be of the remote control type ; as there are two more panels, its capital cost is greater in the case of the gas plant.

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Capital Outlay.—The total capital cost of the respective steam and gas plants is then estimated as under:—

Steam Plant.

	£	s.	d.
Five 2,000-k.w. turbo-generators, erected complete	39,500	0	0
Five surface condensers with air and circulating pumps	9,875	0	0
Circulating pipes	1,200	0	0
Cooling towers erected complete	6,900	0	0
Twenty water-tube boilers erected complete with mechanical stokers, economizers, superheaters, feed pumps, water-service tank and feed tank, water-softening plant, and all pipe work ...	31,300	0	0
Buildings with engine and boiler foundations, two chimneys and flues	33,600	0	0
Overhead travelling crane	1,000	0	0
Steel structural work, coal bunkers, coal and ash conveying plant	8,900	0	0
Exciters, battery, switchgear, and connections to generator	7,250	0	0
	£139,525	0	0

Or £13·952 per kilowatt installed.

Gas Plant.

	£	s.	d.
Seven 1,450-k.w. gas engines, generators, air compressors, gas, water, air, and exhaust pipes, and all auxiliaries erected complete...	98,000	0	0
Four ammonia-recovery producers, erected complete with superheaters, blowers, cooling and washing towers, centrifugal cleaners, scrubbers, ammonia absorber, and all pipe work	18,490	0	0
Duplicate blower, washer, and centrifugal cleaners...	3,780	0	0
Four non-recovery producers with necessary scrubbers, etc.	10,340	0	0
Steam-raising plant, economizers, feed pumps, etc....	4,850	0	0
Water-cooling towers, pumps, and water softener ...	1,990	0	0
Buildings and foundations, etc.	24,275	0	0
Overhead travelling crane	1,250	0	0
Steel structural work, coal bunkers, coal and ash conveying plant	6,150	0	0
Exciters, battery, switchgear, and connections to generators	7,750	0	0
	£176,875	0	0

Or £17·68 per kilowatt installed.

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Operation of Gas Plant.—As there are probably many engineers interested in the design of power stations who are not familiar with the method of operating a combined producer and gas-engine station, a few words on this subject may not be out of place before considering the comparative running cost of the respective systems.

The coal is fed by means of the endless chain elevator into bunkers above the producers, from which it gravitates through a valve to the hoppers. From the hopper it is fed into the producer from time to time as the fuel therein gradually burns away. The ashes are regularly withdrawn through the water lute every four hours, the quantity being determined by the rapidity of combustion in the producer.

The hot gases escaping from the outlet at the top of the producer pass into the superheater, which consists of a series of vertical pipes surrounded by the steam and air passing on their way to the producer. A considerable portion of the sensible heat is herein extracted and utilized.

The gas is then passed to the mechanical washer, where it is treated with a spray of warm water thrown up by revolving paddle-wheels. The dust and soot in the gas are by this means removed and the temperature of the gas considerably reduced. The warm water is also at the same time heated up and passed to the air saturator, in which, by heating and saturating the air on its way to the producer, it is cooled for further use in washer.

Passing from the washer, the gas next enters the mechanical ammonia absorber, where it meets a fine spray of a solution of sulphate of ammonia, which contains a small amount of free sulphuric acid. In this apparatus the acid in the solution combines with the ammonia in the gas, producing sulphate of ammonia. The acidity of the liquor is kept up by a small trickle of sulphuric acid into the absorber; the sulphate liquor, which is continually being augmented in volume by the new sulphate of ammonia formed, slowly and continuously trickles out of the absorber to the stock liquor tanks.

Following the passage of the gas, it is next treated in a mechanical gas cooler, where it meets a spray of cold water, and where it gives up the bulk of its tar. The gas leaving this cooler passes to the air regulator, which is merely a small gas-holder, the height of which regulates the quantity of air supplied by the blowers. Thence the gas passes through two centrifugal cleaners in series, which, revolving at high speeds and in conjunction with a small amount of injected water, effectually remove all but very small traces of the tar contained. These latter are removed by passing through the sawdust scrubbers, whence it emerges in a thoroughly cool and purified condition and enters another gas-holder, which serves to keep a constant pressure in the supply main to the gas engines.

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The non-recovery process (the apparatus for which is shown on the left of the general lay-out drawing, *Fig.* 4) is very much simpler. The gas, in this case, passes direct into the cooling washer, and from this, through the gas regulator and centrifugal cleaners, to the scrubbers and engines.

Running Cost.—The fuel consumption of a gas plant, as of a steam plant, is dependent upon at least four important factors :—

1. The actual output, which in an electric generating plant will be expressed in kilowatt-hours generated.
2. The no-load losses, which include friction, windage, and electrical losses incurred in running the generator on open circuit, together with all power required for exciters, pumps, and other auxiliaries.
3. Stand-by losses of banking boilers or producers.
4. The ratio of the actual ascertained fuel consumption under day-by-day working conditions to the theoretical consumption based upon test results applied to Items 1, 2, and 3, which will be termed the discrepancy factor.

Stand-by Losses.—The losses through radiation of heat and through leakage of all sorts is a heavy item in all steam-driven electric generating stations, as the conditions of load are generally such that the majority of the boilers are banked for many hours every day.

The fuel required for banking producers is only a small fraction of that required for banking boilers. The actual estimated quantities are 448 lbs. coal per hour per set of boilers for a 2,000-k.w. unit, and 50 lbs. per 1,450-k.w. producer.

Discrepancy Factor.—It is difficult for those who have not had actual experience in running a generating station to appreciate how impossible it is to keep this factor within reasonable limits. For both the steam and gas plants 25 per cent. has been added to the ascertained fuel consumption under test conditions to cover the above contingencies.

Coal Consumption.—For a maximum demand of 8,000 k.w., a load factor of 24 per cent., and a distribution efficiency of 80 per cent. the units generated per annum will be 21,000,000. The authors then give a very interesting method for obtaining the fuel consumption.

This works out to 3·55 lbs. per unit generated in the case of the steam plant, and 2·18 lbs. in the gas plant. These it should be noted are exactly double the figures obtained on test at full load. The annual coal consumption then works out to 33,300 tons and 20,465 tons respectively.

Oil, Waste, and Stores.—The cost of oil as given by various authorities for the steam-turbine plant is estimated at 0·003d. per unit generated, and that for the gas plant about 0·009d., in addition to what is required for the auxiliary plant.

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The cost of waste and stores in both cases is taken at 0·002d. per unit. This works out to a total of 0·005d. and 0·015d., per unit respectively, or to totals of £438 and £1,345.

Water.—The water in both cases, it is assumed, will cost 6d. per 1,000 gallons.

The cost for the steam plant is £2,760 per annum, and for the gas plant £555.

It is assumed that 12 gallons of water are required per k.w. hour for cooling the gas engines. Of this 3 per cent. is assumed to be evaporated. Also 35,000 gallons are required per diem in the producers.

Labour.—The labour charges are calculated upon the assumption that the following staff would be required for the respective schemes :—

Steam Plant.

	£	s.	d.
Three charge engineers at £3 per week ...	9	0	0
Three switchboard attendants at 30s. per week	4	10	0
Four drivers at 35s. per week...	7	0	0
Four assistant drivers or cleaners at 28s. per week	5	12	0
Three firemen at 35s. per week	5	5	0
*Nine boiler house and auxiliary plant hands at 30s. per week...	13	10	0
Three men for unloading coal and removing ashes at 28s. per week	4	4	0
	£49	1	0

Total labour charges per annum, £2,550.

Gas Plant.

	£	s.	d.
Three charge engineers at £3 per week ...	£9	0	0
Three switchboard attendants at 30s. per week	4	10	0
Six drivers at 35s. per week	10	10	0
Five drivers at 30s. per week...	7	10	0
Two cleaners at 28s. per week	2	16	0
Three producer hands at 35s. per week ...	5	5	0
Six producer hands at 28s. per week	8	8	0
Seven ammonia recovery hands at 30s. per week	10	10	0
Two men for unloading coal and removing ashes at 28s. per week	2	16	0
	£61	5	0

Total labour charges per annum, £3,180.

*Includes men for cleaning boilers.

Maintenance and Repairs.—This is the most difficult item to estimate with any degree of accuracy for either the steam or the gas

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plant. It is practically useless citing the experiences of existing stations.

The authors consider that there is no reason why the cost of repairs should be high with a properly designed gas plant. The gas generators should be cheaper to maintain than the steam generators. And so in each case the cost has been put down at a lump sum of £4,000.

Antiquation, Depreciation, and Interest.—The authors do not anticipate that the gas plant will change very much in type for some years to come, and consider that the depreciation would be small. So in both types of plant the figure of 10 per cent. of capital cost is taken under this head. A lower figure, say 6 per cent., comes out much more favourable to the gas plant.

The total running costs of generating 21,000,000 units under the above conditions will, we estimate, be respectively as follows:—

	Gas.			Steam.		
	£	s.	d.	£	s.	d.
Total cost of coal at 12s. per ton ...	12,280	0	0	19,968	0	0
Less sale of sulphate of ammonia ...	5,524	0	0			
Net cost of coal	6,756	0	0	19,968	0	0
Oil, waste, and stores...	1,345	0	0	438	0	0
Water	555	0	0	2,550	0	0
Labour	3,180	0	0	2,590	0	0
Repairs...	4,000	0	0	4,000	0	0
Interest and depreciation at 10 per cent. on capital	17,687	0	0	13,952	0	0
Total cost	33,523	0	0	43,668	0	0
Total cost per unit	0·383d.			0·498d.		
Total cost, allowing 6¼ per cent. for interest and depreciation	£26,900	0	0	£38,428	0	0
Total cost per unit	0·306d.			0·438d.		

Effect of Price of Coal and Load Factor.—In the particular case considered the conditions are favourable for the use of a gas plant, as the load factor is higher than is usual in municipal electric supply schemes, and also it is usually possible to obtain coal for less than 12s. a ton.

Going to the other extreme, and considering the case of a generating station having the poor load factor of 10 per cent., with coal at 8s. per ton, a maximum output of 4,000 k.w., and a load which would not justify the use of an ammonia recovery plant, it is found that the saving in fuel effected by the gas engine is barely sufficient to pay the 10 per cent. interest, etc., charges on the higher capital outlay.

It has been suggested that for such conditions a combined gas and steam plant might be used, the gas plant being utilized for the long

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hour portion of the load curve, and the steam plant with its lower capital charges for the peak load.

A detailed comparison is then made of the three systems—gas, steam, and combined gas and steam—for a 4,000-k.w. station working under the above conditions. The costs per unit are also worked out for different load factors and costs for fuel, and are plotted in *Fig.* 9. The authors show that for *entirely* new stations the combined plant never pays.

From the figure it will be seen that the steam plant comes out the cheapest when the conditions as to cost of fuel and load factor are to the left of the line AB, and the gas plant is cheaper when they are to the right of that line.

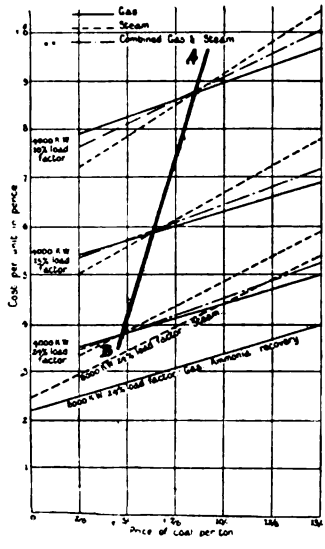

FIG. 9.

There are however many existing installations equipped with comparatively inefficient plant, where a large economy would be effected by installing gas engines which would be used for the flat portion of the curve, the inefficient plant being retained for the peak load and stand-by.

In the discussion which followed there was of course considerable divergence of opinion among speakers.

As the whole question ultimately boils down to the financial and not to the engineering point of view, the criticisms on the finances of the proposed stations will be dealt with first.

Turning to the tabulated costs of the plants, speakers seemed to agree generally that the cost of the steam plant could be cut down to £120,000, partly by putting in larger units and fewer economizers, and

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partly by placing the station near an adequate supply of water. The cost of the gas plant was not criticized, except that it seems assured that the cost will come down considerably in the near future as larger numbers are turned out.

As regards running costs, it was held that 12s. was a high price for coal, and also that a cheaper quality of coal could be utilized in the boilers than in the producers.

As regards water, it was held that the difficulties *re* supply of condenser water for the steam plant were overestimated. Nowadays, with high-tension distribution, the central station could be some way from the electrical "centre of load" without unduly increasing the cost for cables, and so could nearly always be near an abundant or cheap supply of water.

As regards the item of £4,000 for repairs to gas plant, opinions varied largely. Several speakers gave their experiences, some of which were satisfactory, and some the reverse. It seemed to be difficult to eliminate the expenses brought about by lack of experience, installing experimental engines, etc., but on the whole the figure taken was allowed to be as near an approximation as could reasonably be taken.

The result of these criticisms would be to considerably reduce the running costs of the steam plant to a figure which would be very little in excess of those for the gas plant.

Referring to *Fig.* 1, Curve C, which shows the number of hours in a day during which any particular load is maintained, it was held that the proper way to make use of gas-engine plants with their low-running costs is to instal them to generate for the level part of the load curve, and to work them with ammonia recovery, so as to reduce the running costs to a minimum. In this way the interest, etc., on high capital outlay would be borne by a large number of units generated, and would not come to a high cost per unit.

Acting on this principle, it was suggested by Mr. Highfield that the way to introduce gas engines was not to put up huge stations, but to add gas plant to existing steam plant, and use it for as much of the continuous load as possible, and gradually to alter the design of the steam plant, so as to reduce the stand-by losses to a minimum.

This opinion seems to be endorsed by the technical press, which on the whole seems to consider that the wholesale introduction of large gas-engine stations has not yet arrived.

The paper and discussion disposed of the objection to gas engines on the score of the difficulty of running alternators in parallel, and seemed to show that the item for repairs would not be a heavy one. The chief difficulty which it was thought would crop up was that the number of men who are used to working gas plants is very limited, and that through inexperience at first there might be unsatisfactory and uneconomical running.

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TRANSCRIPT.

THE FINAL STRUGGLE FOR 203-METRE HILL AT PORT ARTHUR.

Translation of an article by Staff-Capt. Kostiushko in the March, April, and May numbers of the *Eenzhenernee Zhoornal.*

(*Continued*).

(1). *Fighting on Visokaya and Flat Hills.*

On the 28th November, from 10 a.m. till evening, the Japanese shelled Visokaya, and fired in that interval 25 11″ shells, 80 6″, 60 mines, and 300 other shells of small calibre from field guns, mountain guns, etc.; the bombardment caused a great amount of damage.

General Tretyakov during the day watched the fighting on the right flank and centre, and from what he saw concluded that the Japanese were transferring the attack to the left flank, and towards evening he passed the following order along the position:—"I am expecting an attack on our positions. Let everything be in readiness to offer due resistance.—Colonel Tretyakov." The companies of the reserve were ordered to stand by in readiness near the 5th Regiment headquarters, and the trenches of the 2nd line, *i.e.*, those lying between Forts Nos. 4 and 5 (Red Hill, Fougasse, Two-Angled, and New Lunettes), were occupied by the companies of non-combatants allotted to this section, *i.e.*, those of the 5th, 13th, and 28th Regiments.

The reason that the non-combatants were ordered to occupy positions was because even during the earliest fighting at Port Arthur it was felt that the garrison was too weak in numbers. To make up the deficiency the corps of Port Arthur Foot Town Guards was formed, but as even then numbers were insufficient, after the sanguinary fighting in August and September, General Stessel ordered all non-combatant establishments to be reduced to a minimum and all men thus saved to be sent to the positions. In consequence of this, not only the staffs of clerks, bakers, and other specialists were reduced by about one-half, but even in each of the Officers' Messes only three men were left, and those preferably men who had recently come out of hospital after having been seriously wounded.

Officers' private servants were also reduced and replaced by wounded men, and the men of the bearer companies, required for carrying the wounded, were replaced by the remainder of the clerks and musicians. In a word, General Stessel arranged that during the fighting not a man should be wasted. But in spite of this an insufficiency of fighting men

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was experienced. Then he went further and ordered that all non-combatants, except the drivers in charge of the travelling kitchens and the ammunition carts, must go to the positions. This measure supplied about 1,000 fighting men, but as on their departure all regimental routine was at a standstill, he further ordered that when no attack was either going on or immediately expected, these non-combatants were to carry on their usual work.

In case of need they had to come up at the first call, and as General Tretyakov summoned his non-combatants into position, it is evident that he had no doubt that his section was about to be attacked. And so it was.

The Japanese kept up a steady rifle and artillery fire on Soloviev's position all day and all night, in the hopes of drawing off attention and reserves from Visokaya Hill.

On the *28th November*, from 9 a.m. till evening, they kept up a heavy fire on Visokaya, and expended about 800 11″ shells, 300 6″ shells, 20 mines, and more than 1,000 smaller shells.

On this day the Japanese artillery directed all their fire on the redoubts excavated in the rock on the two summits of the hill. The redoubts were much damaged; in places the 11″ shells cut off great masses of granite half the size of a cottage, which fell down and in places completely blocked the trenches; but as the infantry were in the ring trench, and the redoubts during the bombardment were occupied only by sentries, the losses were very small in comparison with the number of shells fired.

Towards evening General Tretyakov, expecting an attack, sent the 7th Company, 14th Regiment, to reinforce Visokaya Hill, and the 12th Company, 5th Regiment, to Flat Hill; but both companies eventually went to Flat Hill, as by the time they came up it was evident that they were more needed there.

At 5 p.m. the Japanese infantry attacked Visokaya, but were repulsed. At the same time they attacked Flat Hill, and here they were at first successful, driving out the remnants of the 5th Company, 27th Regiment; pressing on to the Stony Redoubt, they had even burst into it, when the reinforcing companies came up in time and beat them out.

In this struggle the 4th Section, 7th Company, 14th Regiment, under Sergt. Loshkarev, especially distinguished itself. Arriving with the rest of the company at Flat Hill, this N.C.O. got leave to lead forward his section against the Japanese, who had got into the Stony Redoubt and were collected there in bunches, uncertain what to do next and probably waiting to be reorganized.

This gallant section, without waiting for the Japanese to recover themselves, charged into them with the bayonet. They lost their heads and rushed back, practically offering no opposition. The remainder of the company then came up, followed by the 12th Company, 5th Regiment; under Lieut. Ivanov, and drove the Japanese from the lower trenches also.

About 6 p.m., just as the Japanese had broken into the redoubt, one of the columns driven back from Visokaya attempted to seize the saddle between Visokaya and Flat Hills; information was sent forthwith by telephone to the batteries, which immediately opened a heavy fire on the column. At the same time rifle fire was brought to bear upon it from

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Visokaya. Entrenchment No. 4 was the first to open an especially successful fire on this column. Under this combined fire the column fell back, but in the darkness it was difficult to estimate its losses.

In the centre of Flat Hill the Japanese also had some success, but were driven back by half of the 9th Company, 5th Regiment.

By 8.45 p.m. the Russians were everywhere re-established in their original positions, and while some engaged in a hand-grenade fight with the Japanese, others repaired their damaged works.

The riflemen who took part in this fighting, when they considered the undecided action of the Japanese in the captured redoubt, so different from their usual ready way of adapting themselves to circumstances and their previous stout resistance to counter-attacks, decided that they must have been recruits. It was also noticed that the few wounded Japanese who were captured were young-looking men. These appearances led to a rumour that the Japanese were nearing the end of their resources, and in order to replace their enormous losses had to draw upon untrained recruits and youths of 18 and 19.

In the evening the non-combatant company, 5th Regiment (81 men), was sent to Flat Hill; the 12th Company, 5th Regiment, took over on Flat Hill part of the trenches of the 5th Company, 27th Regiment.

At about 6 p.m., in the thick of the fighting on Flat Hill, several alarming telegrams came in. From Division Hill it was reported that fully a company of the enemy were lying under the slope near the 3rd Company trenches, and that opposite the left flank of Division Hill the Japanese were coming forward in groups from Dead Knoll. From Flat Hill reports arrived that the Japanese had broken in and the hill was in great danger, and that reinforcements were urgently necessary; and from Visokaya that the enemy's columns were moving between Visokaya and Flat Hills.

Among the others, the following message was received :—"To-morrow, by order of General Fok, General Nedein and I are coming to inspect the biscuit store of the 5th Regiment.—Staff-Capt. Shelkovnikov." In spite of the want of consideration on the part of the commander of the 4th E. Siberian Division, which this message, sent at such a time, displayed, General Tretyakov found time to make suitable arrangements, and on the following day the supply officer, Staff-Capt. Felitsin, commanding the non-combatant company, with the quartermaster, Lieut. Frost, and a few drivers—the rest of the non-combatants being then on Flat Hill—were taken away from their work for several hours.

On the 29th General Irman ordered, by telephone, Capt. Romanovski, commanding the 2nd Division of the West Front of the Land Defence, to send the section of quick-firing artillery, commanded by Lieut. Siromyatnikov (2nd Battery, 4th E. Siberian Rifled Artillery Brigade), from Lyaoteshan, to a position at the village Liudzyatun, near Pigeon Bay, with the object of sweeping with fire the southern and western slopes of Visokaya, and thus striking the Japanese attacking columns in flank and rear.

The General sent a special message to this officer that he must assist the defenders of Visokaya Hill by every means in his power, and that their chief hope lay in him.

30th November.—In two hours, *i.e.*, between 3 and 5 a.m., Lieut.

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Siromyatnikov brought his two guns into position behind a low hill, which successfully concealed them from the enemy's view, without impeding their fire by its sloping sides. A gently sloping rise in rear of the guns blended imperceptibly with the foreground, and thus masked them from Japanese detection. Firing began at dawn, but was penalized by the bad quality of the fuzes, which frequently failed to burst the shells.

The observation post was skilfully selected on the crest of the hill in front and to the left of the guns, and, masked by Chinese tombs, the observers got a good view of Visokaya Hill and the approaches to it from the enemy's side. They remained continually on the alert, and when the Japanese advanced they promptly opened fire on them.

A few well-aimed shells compelled the Japanese to disperse and take cover in their approaches, where these guns, which were equipped with nothing but shrapnel, were unable to touch them. In the evening they were reinforced by another section, under Staff-Capt. Nezhentsov, but unfortunately the limited supply of shells prevented their fire from being developed as much as the occasion demanded.

These guns kept up their fire by night, using as a stationary directing object the Lyaoteshan Lighthouse, which was situated about 5 versts in rear of the position. The Japanese did not direct any serious fire in their direction, but from the occasional common shell which fell in their vicinity it appeared that they were searching for their position.

With a view to diverting attention from Visokaya Hill and depriving the Russians of a position which commanded their approaches to that point, the Japanese before dawn advanced once more against Soloviev's position; but after three attacks had failed, at about 5 a.m. they desisted, and contented themselves with shelling the Pigeon Bay defences.

30th November.—The Japanese continued the whole night shelling Visokaya and Flat Hills, and although their fire was weaker than it had been during the day, yet the damage done exceeded in extent the repairs which the defenders managed to carry out. At dawn the fire increased, and at that moment they again advanced to the assault. The 4th Company, 7th Reserve Battalion, was sent up to Visokaya at 8 a.m., and a composite company of the 3rd Division (71 men) at 8.20. So impetuously did the Japanese press the attack that a few men gained the left peak of the hill and there posted a flag, but owing to the timely arrival of reinforcements the attack was repulsed, the gallant men who had reached the crest were slain, and the flag thrown down. After this the Japanese began collecting under the hill for a fresh attack.

At 10.30 a.m. the non-combatant company, 15th Regiment, was sent to Visokaya Hill, and as no more reserves remained with the staff of 5th Regiment, General Tretyakov ordered the 1st Company, 7th Reserve Battalion (Staff-Capt. Diukin, 89 men), which had just been sent as a reinforcement to Flat Hill, to go over to Visokaya. This shows clearly how urgent was the need of reinforcements.

Meanwhile the Japanese maintained a strong artillery fire, which caused enormous losses. About 11.0 they carried out a fresh attack, but owing to the timely arrival of reinforcements it also was repulsed. About 11.40 the artillery fire ceased, their infantry went away, and quiet lasted for about an hour. They were probably having their dinners. The

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Russians sent down urgent messages for food to be sent up to the positions, but owing to want of haste and also to the stocktaking in the biscuit store, no food arrived before 12.30, just as the Japanese reopened their fire, and with such energy that even 11″ shells fell three or four at once. The men grew fewer and fewer, and all the local reserves were expended in replacing the dead. At 2 p.m. the 6th Company of the Kwantung Naval Detachment (109 men), under Lieut. Pashkov, was sent to Visokaya, and a little later the non-combatant company, 14th Regiment (100 men), under Lieut. Lokoshchenko, and also the non-combatant company, 16th Regiment (121 men), under Lieut. Yenkovich.

On Flat Hill nothing of importance was happening, but the trenches of the two companies on the left flank (the 5th and 8th Companies, 27th Regiment) were wrecked and many of the men put out of action. The commandant, Lieut.-Colonel Budyanski, expecting a night attack, called urgently for reinforcements, but there were none to send; in fact, both General Tretyakov and General Irman received refusals from headquarters to their own pressing and reiterated requests for more men to be sent to them. The 7th Company, 27th Regiment, which came up at about 2.0 p.m., was at once sent to Flat Hill, and the only reserve which remained with the 5th Regiment Staff was a half-company of sailors, landed from the *Amur* (71 men), who were kept back in case of the enemy breaking in between Flat Hill and Visokaya.

Meanwhile at 3.10 p.m. Capt. Stempnevski I., commanding on Visokaya, reported that in the centre of that hill all the blindages were wrecked, on the right flank almost all were choked with earth, that many of the men were crowded together and buried in the blindages, and there were no spare hands to assist in digging them out, and in any case this was impossible owing to the fire; the communication trench leading to the centre was blocked in two places, and all communication had become very difficult. It was also reported that the losses were enormous and reinforcements very necessary.

At 3.20 p.m. Lieut. Erofeev, who was observing the front of Visokaya from Pigeon Bay, reported about a company of Japanese lying to the east of some groups of stones under the left peak, and that east of their communication trench dense lines of Japanese were climbing out of their saps, and more still were following them. Evidently they were preparing another attack on the hill. Generals Tretyakov and Irman again urgently begged for reinforcements, but the only answer they got was that there were no reserves left, and that Visokaya Hill was expending such a large number of reinforcements that they must really be more economical.

As soon as, by continuous pounding, the Japanese had thoroughly prepared the way for success, at 4.30 p.m. they advanced up Visokaya Hill in dense masses. The attenuated Russian line had no power to resist them, and they occupied the front, or western, part of the ring trench.

Stempnevski now reported by telephone that the Japanese were crowding into his position in large numbers, that he had not got sufficient men to hold it any longer, and begged for permission to give it up.

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General Tretyakov wanted to go up to the hill in order himself to take over the superintendence of its defence, but his staff restrained him; whereupon he sent an order to Stempnevski to hold the top at all costs. At the same time the condition of affairs on the hill was reported to the Staff of the Land Defence.

Tretyakov now ordered the 5th Company, 5th Regiment, on Division Hill, to come at once to the 5th Regiment headquarters, and the 7th Company, who were alongside them, to spread out into the 5th Company trenches. General Irman, who had been following the fight on Visokaya with field glasses from Fougasse Hill, now returned to 5th Regiment headquarters and confirmed Tretyakov's dispositions. He thanked him, and when at 5 p.m. he got into conversation through the telephone with General Kondratenko, he told him that the hill had only been held hitherto by the energy and resourcefulness of General Tretyakov. At the same time he sent the following report to the Fortress Staff:—"The Japanese have occupied nearly the whole of Visokaya. The whole of the trench on Flat Hill is in their hands. I am expecting them to break in, and have in reserve only a half-company of sailors.—From General Irman; 5 p.m., 30th November."

Both the Land Defence Staff and also General Stessel sent orders to hold Visokaya at all costs.

After this alarm as to the fate of Visokaya had been realized, reinforcements began to arrive in some proportion to the urgency of the case. General Kondratenko, anxious about the hill, came himself at 6 p.m. to the 5th Regiment headquarters, in order that he might become more closely acquainted with the conditions and give his sage advice.

All met this heroic man with joy, and felt more confident in his presence. By his gracious tone, his kindness, and tranquillity—rare qualities, which did not desert him even for a moment—he was universally welcome.

Meanwhile conditions on Visokaya had become worse and worse. Having established themselves in the ring trench, the Japanese climbed up to the redoubts and on to the saddle. They captured part of the left redoubt, but in the remaining parts, thanks to the vigorous action of Stempnevski, a desperate struggle was maintained.

General Tretyakov, fearful for the fate of the hill, eventually rode up to take immediate charge of the fighting. On the way his horse was wounded in the foot by a rifle bullet fired from the hill, which gives some idea to what extent it was then occupied by the Japanese.

At 9.30 p.m. the following telephone message was received at the 5th Regiment Staff, and immediately transmitted to Tretyakov on Visokaya:—"From General Stessel. To Colonel Tretyakov. I order you to defend Visokaya Hill like Bayazid. It is a most important point."

When Tretyakov on arrival had taken up the direction of the defence and had personally ascertained the state of affairs, he reported:—"The trenches on Visokaya are destroyed, the blindages broken, and its maintenance is very difficult. I will do what I can." Then collecting the newly-arrived reinforcements and distributing the men among the various areas, he led them forward to drive the Japanese from the trenches which they had occupied and from the left redoubt.

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The following reinforcements reached Visokaya Hill before midnight, but their times of arrival are not accurately known:—5th Company, 5th Regiment, 89 men, Capt. Fofanov; two companies of seamen from the *Amur*, 20 men; 7th Company, 7th Reserve Battalion, Lieut. Antonov, 44 men; composite company, 28th Regiment, Sergt.-Major Kurnosov, 71 men; half of the 8th Company, 26th Regiment, 60 men; and at 2 a.m. on the 1st December, the 3rd Company, Naval Battalion (from the ironclad *Pobieda*), Midshipmen Bershadski and Fleisher, 171 men.

The first counter-attack was unsuccessful; the companies took the wrong direction and then fell back at 10 p.m.

Just then, another company coming up, General Tretyakov added it to his forces, and again distributed the companies to areas, encouraged them, and personally led them to the attack.

The night was dark; all around were heard the crackling of rifles, the sharp cries now of the Russians and now of the Japanese, the bursts of hand grenades, and the deafening crashes of large and small shells. In the darkness, from time to time, now here, now there, the Russian riflemen lighted up Roman candles, improvised for them by their mining officers.

In this night fighting success sometimes favoured one side, sometimes the other. To avoid going into too great detail, it will be sufficient to record here only one important and interesting occurrence.

The reinforcing companies, encouraged by General Tretyakov, moved forward rapidly, but as they approached the Japanese they stopped; cries were heard, disorder spread among them, and the next moment they had broken backwards, carrying away with them the line which had hitherto stood firm. The whole hill was cleared in a moment. The ruin appeared to be irretrievable, and no power could turn the flying men. Near General Tretyakov, among a small group of riflemen and one or two officers, stood Ensign Ermakov, and to him Tretyakov gave orders to run down the hill and turn back the runaways, while he himself, brandishing his sword, began exhorting those who were left, imploring them to remember their oaths, their Faith, and their Tzar. In the end, seeing little prospect of success, he exclaimed in despair "Well, then, retire; I alone am going to retake the hill."

Among the garrison were many men of the 5th Regiment who loved their commanding officer and were touched with shame, so that voices began to be heard, "Brothers, the Commandant of the Regiment is left on the hill; we must go and rescue him." Whereupon this living wave, with Ermakov at their head, broke back up the hill. Tretyakov, taking advantage of this enthusiasm, lost no time in leading the men against the Japanese, and with him in front of the attack went Lieut. Fetter, of the Mining Company, Ensign Ermakov, and others. In this attack the men of the various corps were so intermingled that there was no question of rearranging them in their companies.

The Japanese were already occupying the summits of Visokaya when this attack burst upon them, and so impetuously was it pushed home that not only the redoubts, but even the trenches below them, were recovered. Only a very small section of the trench on the left flank remained in the hands of the Japanese, and all attempts to drive them

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out of that failed. But this short length of a few paces had little importance; the hill had been recaptured, and the full credit belonged to General Tretyakov, and to his faculty of not losing his head in a moment of difficulty.

General Irman reported the occurrence in the following words:—"To the Fortress Staff. From the 5th Regiment Staff. The Japanese have been beaten from all the trenches, and the whole of Visokaya is in our hands, thanks to the energy and initiative of Colonel Tretyakov. The repairing of trenches has begun.—Colonel Irman, 12.50 a.m., 30th November—1st December."

The Japanese were driven from the hill at about midnight. The joyful news flew through the city, which was anxiously awaiting the result of the fighting. Some idea of the general relief may be gathered from the following message received from General Stessel at 1.30 a.m.:—"Hoorah. You heroes will receive worthy rewards. Thanks to Irman, to Tretyakov. I embrace you all heartily.—Stessel."

After having repulsed the Japanese, Tretyakov set to work to reorganize his command and to repair damages, which latter work included the clearing of trenches and communications, excavating collapsed blindages, and repairing the wire entanglements.

Against Flat Hill the enemy from daybreak had opened a powerful artillery fire, and after dinner they threw several mines, endeavouring thereby to destroy two machine guns which were posted in the trenches of the left flank. The machine-gun detachment, which consisted of sailors, frequently changed the position of these guns, and at last withdrew them altogether from the parapet and hid them in the trench, "to escape the attention of the Japanese gunners." With one of the guns was 1st Class Seaman V. D. Perevozchikov, of the cruiser *Pallada*.

For some time the Japanese infantry had been collecting in the parallels on the slope of Visokaya, and in that nearest to Flat Hill two companies, each numbering from 250 to 300 men, were crowded. It was evident that they were preparing for an attack on Visokaya, and while awaiting the appointed hour, not anticipating any danger, some were sitting and others lying in the sap, making themselves as comfortable as circumstances permitted. Their rifles were leaning against the parapet, and in two or three places the smoke of fires was peacefully rising. On noticing this, the sailors of the machine-gun detachment quickly planted their guns in a spot from which it was possible to enfilade this parallel, and about a score of the most skilful riflemen joined them. All took careful aim, and when everything was ready they fired together.

The Japanese trench at once awoke to a scene of the most frightful confusion. The men threw themselves from side to side like madmen, in fruitless search for cover; some leapt out of this unexpected tomb and as if on wings dashed down the hill, but here the bullets caught them before they had succeeded in reaching a place of safety. In a minute or two the turmoil had ceased. The parallel was filled with dead bodies, and looked more like a combined grave than a trench, and it is needless to say that the Japanese did not again collect in it.

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At 3 p.m. an attack by the Japanese infantry was made against a small portion of trench in the section of the 12th Company, 5th Regiment, on the left flank of Flat Hill, near the dead ground. This section had suffered very heavily from artillery fire, and at the moment of attack was defended by only nine riflemen, the rest having been killed or wounded. The Japanese rose unexpectedly from the dead ground; the defenders opened fire on them, but some found their rifles choked with dust and had to have recourse to their bayonets. Several perished in the hand-to-hand struggle that ensued, and the rest fell back to right and left along the trench. After this the Japanese were pelted with hand grenades and fired on with rifles, and they replied in the same manner; and in this way about an hour passed.

By this success on the part of the enemy the 12th Company was cut in two, and volunteers were promptly called for from the two half-companies to advance simultaneously from both sides and restore connection. From the 2nd Half-Company there came forward Zakharov, senior sergeant of the 3rd Section, Sergt. Tvorogov, Corpl. Yakimov, and Town-Guard Vavilov, and from the 1st Half-Company Rifleman Polyakov, and the rest followed them. After throwing hand grenades into the trench and firing at those of the enemy who were in the act of climbing over the parapet, the volunteers of the 2nd Half-Company dashed forward until they had joined hands with the 1st Half-Company.

Many dead and severely wounded Japanese lay in the trench, and among them, concealed by a traverse, were three only slightly wounded. Unaware of their presence, Tvorogov and Yakimov advanced along the trench and were promptly bayoneted. The men who rushed to their assistance took vengeance on all the Japanese who were found alive in the trench for the destruction of their brave comrades; but Tvorogov and Yakimov, who had always taken the lead in their company's charges, expired after about half-an-hour's agony.

Meanwhile the damaged parapet was built up with Japanese corpses, and preparations were made for meeting a fresh assault, which came off almost simultaneously with that on Visokaya Hill at about 5.15 p.m. As before, the Japanese were at first successful in a few places, but were eventually driven back at all points, losing a few prisoners.

On this day, the 30th, the Russians lost about 1,000 men, and the Japanese probably about 3,000.

At 11 p.m. Staff-Capt. Belozerov took over command of the hill from Capt. Stempnevski I.

At that time the receipt of an order to go to Visokaya Hill amounted practically to a sentence of death. Thither daily many went, but rarely did one return. Generally, in not more than an hour after moving off, the more fortunate (wounded) were carried back on stretchers to the hospitals; the less fortunate (killed) no one troubled about, but left them on the hill.

But, after all, the conditions in November for the wounded were so horrible that it would be difficult to say who were more fortunate, they or the killed. The dead at any rate were out of pain, and for them every place was suitable, everywhere there was room. But for the wounded it

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was necessary to look for room; and where could they look, when all the hospitals were full, not only the beds, but even the very floors of the corridors?

In the hospitals it was customary to place the beds two together, so that each pair could take three wounded. On the news arriving that a fresh assault had begun, in order to make room for a fresh influx of wounded, all those whose wounds had begun to heal, or who could use their legs, were sent out to join the detachments of invalids, or to the ranks. For two or three days afterwards they were allowed to visit hospital for dressing or medicine; and many used this privilege, so that towards the end of the siege as many as 3,000 daily were attending the hospitals in Arthur. But it is difficult to say how many in the ranks were really fit.

But these measures were insufficient, and during a serious attack the influx of wounded men was so great that all available space was filled in the course of the first day.

The fighting on Visokaya followed immediately upon the assaults of the 28th November on Forts Nos. 2 and 3, so that the hospitals were full to overflowing before this fighting had even begun. During the fighting the bearers carried their wounded to the nearest hospital, and if they found a spare place they left him there. Failing this they laid down their stretcher in the corridor without asking whether the hospital could take him in or not. But when the corridors were full and no room could be found, they had to carry him to a second hospital, and then to a third, and so on. Sometimes these journeys took many hours, if not a whole day, all the hospitals being visited in turn. In this way it not infrequently happened that the wounded man could not endure such treatment, and died before he could be crowded in anywhere. Nor was this surprising; the men were extremely exhausted with hard work, poor food, and want of rest, and their wounds, with loss of blood and physical suffering, added to their weakness. They wanted warm rooms and rest, but instead of this they were borne in the cold all round the filthy streets of Arthur, and their painful condition was exposed in all its nakedness and horror.

The stretcher-bearers also were placed in a position of great difficulty. The hospitals could not receive the wounded, and there was nowhere else to take them. But what could they do? They could not leave them in the middle of the road, and yet where was there to take them?

Within the hospitals work went on unceasingly, attendants striving to clear the corridors, Sisters of Mercy attending the wounded on their arrival and trying to ease their sufferings, and surgeons with pale, tired faces performing endless operations. They worked all day and all night. Sometimes they stopped for two or three hours in the night, to begin their terrible work afresh at 6 a.m. next morning; but even then they got no rest, for they felt that those minutes of leisure were gained only at the cost of human lives.

They worked on indefatigably to the sound of shells crashing overhead and occasionally even striking the hospitals. Thus, for instance, over the Composite Hospital shells were continually shrieking; some fell in the

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yard and close to it, and one actually struck the room next to the operating theatre. But all the same those heroic surgeons, Giubbenet and Ivanov, took no notice of the danger, and with cheery good humour went on with their work.

The 9th Hospital was the first to receive damage, as a shell struck it in the first bombardment of the town during August, and in subsequent bombardments shells fell in the yard and out-buildings, and occasionally in the building itself. After the fall of Visokaya Hill the upper storey was rendered uninhabitable. In this hospital that skilful surgeon, Krzhivets, without relief or rest day or night, performed operations unceasingly. Pale, silent, and stern of countenance, he carried out the most difficult work. For instance, under the eyes of the writer he put 14 stitches in the intestines of a non-commissioned officer who was wounded in the stomach, doing the operation with marvellous confidence and rapidity. The impression produced upon the writer was such that if he were ever wounded and required an operation, he would pray to be given into the hands of this man. Under his knife he would die happily.

He would also trust himself in the hands of Giubbenet and Ivanov, and also in those of the surgeon of the Red Cross Hospital, Mirotvorets, and yet in their case a certain amount of pity was felt for the patients, while no one pitied those of Dr. Krzhivets.

Both the 6th Mobile and the 6th Reserve Hospitals were seriously damaged by shells. The Dalninski Hospital, since the first bombardment, had to move four times. But every hospital was exposed to danger, and in each unnoticed but heroic men worked unceasingly without relief or rest. In fact, the surgeons in Port Arthur earned the character of heroes without fear and without reproach, gallant in heart and in their work.

The same respect is due to the Sisters of Mercy; in an unostentatious manner they also carried out most heroic work.

On the evening of the 30th November the gallant naval lieutenant, Deichman, fell on Visokaya Hill. It was due to his enterprise that some time previously a Japanese war vessel was blown up in Kerr Bay. This is how it happened:—

The Japanese wanted to make Kerr Bay, which had been mined by the Russians, navigable to their ships, and had consequently dragged away the mines, and in this way formed a channel, which they marked by buoys, consisting of anchored barrels.

Deichman begged permission to be allowed to make a trap for the Japanese, and taking a few trusty naval volunteers on a dark night about the 15th May, he went in one or two small boats and removed the casks to the area into which the mines had been dragged. In the greatest danger this gallant party worked the whole night without being discovered.

At dawn on the 17th May a Japanese cruiser, probably the *Asama*, approached Kerr Bay, and guided by the casks she struck on a mine. The scene of the disaster was marked on that day by her masts, which alone rose above the surface of the water. On the 19th May, in the

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presence of the 5th Regiment at Kinchow, General Stessel publicly thanked and decorated Deichman, who also received many congratulations from the officers of the 5th Regiment, but replied, modestly, that he had only done his duty.

After Kinchow the writer lost sight of him, but he became famous in Port Arthur for having broken through the Japanese blockade with despatches for Kuropatkin, and returned shortly before the fighting on Visokaya Hill. After this he volunteered for service on land, and having asked for an appointment in the 5th Regiment, was given the command of the 6th Company, which happened to be vacant.

At 6.30 on the dark evening of the 30th November, when the storm on Visokaya Hill was at its height, and anxious watchers were awaiting news with sinking hearts, the 6th Company stood at the headquarters, 5th Regiment, awaiting the order to proceed to the hill; Deichman, after receiving a few final orders from General Kondratenko, came up to them and greeted them cordially as their new commander. He met with a cordial reception, and telling the men that they were ordered to the hill, and that there they would have many opportunities of becoming better acquainted with him, he marched them up and reported to Stempnevski, who was arranging an attack to drive the Japanese from the redoubt on the right. This attack was carried out from three sides by three separate parties; on the left Stempnevski himself made a demonstration with a few men using rifle fire and grenades; in the centre Deichman charged in with 10 volunteers, but was immediately killed with a bullet through the forehead; and after that 15 men, with naval Lieut. Morozov and Ensign Ermakov at their head, advanced towards the redoubt, and after hurling a few grenades, went in with the bayonet; but most of the Japanese succeeded in getting away, except a small party who were caught sitting in a blindage. This party having been disposed of by grenades, the redoubt was finally cleared of the enemy. Both of these last-named officers distinguished themselves by many deeds of valour on Visokaya Hill.

On that same evening another gallant officer, Staff-Capt. Vanikovski, commanding the 7th Company, 14th Regiment, also fell. He was killed by a stone thrown up by a bursting shell, and his men, who went out into most dangerous ground to recover his body, bitterly lamented his loss. The commander of the 4th Company, 15th Regiment, Staff-Capt. Borzinski, and Staff-Capt. Rozhanski, of the same regiment, were also wounded on this day by a bullet which ricocheted from Ensign Ermakov's rifle.

1st December.—Visokaya Hill was bombarded all night with every sort of shell, and although the firing was less intense than it had been during the day, yet the damage done exceeded the repairs which it was possible to carry out during the night, while the continual firing kept the garrisons of both hills in a state of extreme anxiety. Another demonstration was made in the direction of Pigeon Bay, but Capt. Romanovski, with his detachment, did not allow it to advance far.

At 6.30 a.m. some Japanese infantry moved forward against the right flank of Visokaya, but were easily driven back, owing to the failure of

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their main attack against the left redoubt, which was dispersed by the quick-firing guns in the neighbourhood of Pigeon Bay.

During this day these guns, under Staff-Capt. Nezhentsov and Lieut. Siromyatnikov, were especially successful. This was due to the fact that one of the sections had with it about 80 Chinese common shell, which, though intended for use with ordinary powder, were nevertheless suited to the Russian guns, and proved an unpleasant surprise to the Japanese, who had hitherto gained complete cover from shrapnel in their trenches and blindages.

Selecting the moment (6.30 a.m.) when the Japanese were massing for the attack, these officers opened a rapid and well-directed fire on the trenches. The Japanese, finding that their trenches no longer protected them, retired downhill and round to the north, and 40 shell were sufficient to disperse the column intended for the attack on the south-west slope of the hill.

At 7.30 a.m. an order was sent by telephone to Staff-Capt. Marchenko, commanding the 8th Company, 5th Regiment, on False Hill, to detach a section to occupy a small unnamed knoll in rear of Visokaya, in order to prevent the enemy from gaining access to the Tea Ravine, between Flat and False Hills, in the event of the fall of Visokaya Hill.

At the same time the 6th Company, 15th Regiment, under Lieut. Silvin (120 men), and a company of about 91 sailors were sent to reinforce Visokaya. At 8 a.m. Staff-Capt. Belozerov reported their arrival, and also that large reinforcements were arriving for the Japanese from beyond Angle Hill.

At 7 a.m. the Japanese increased their fire on Visokaya Hill with 11″ and 6″ shells and with mines, and maintained it until evening.

At 3 p.m. Belozerov reported that only two of the blindages on the left flank remained uninjured, and that these were occupied by sailors. All the rest were wrecked, and it was hard to say how many men were buried in the débris, as communication along the trenches had been interrupted.

While the artillery fire was thus destroying the works and causing great losses among the men, the Japanese infantry were able to approach without molestation and mass secretly in their saps and approaches, and at 4 p.m. these masses moved forward to the assault.

With their trenches interrupted and their numbers terribly thinned, the Russian riflemen, reduced to a few disconnected handfuls, were unable to resist the shock of the advancing masses, and all perished, while the Japanese penetrated to the very summit of the hill and there planted their flag. General Tretyakov had only 100 men in reserve when he was informed of the sudden appearance of the Japanese on the crest. On the left summit the enemy's flag was floating, and thither dashed Belozerov with a section hastily taken from this reserve.

This example of action encouraged all, and simplified matters for General Tretyakov, who forthwith sent another section in support, and himself led the rest against the saddle and the right redoubt. Lieut. Seifulin, 5th Regiment, who was also on the hill, took an active part in driving back this assault.

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The following reinforcements were then sent to Visokaya Hill:—

A composite company from the boat reserve (155 men, under Lieut. Normand).

The company landed from the *Poltava* (109 men, under Lieut. Baranov and Midshipman Yunkovski).

The company landed from the *Sevastopol* (87 men, under Midshipmen Petrov and Shnakenburg).

And to Flat Hill the following hospital detachments:—

1st. 150 men, under Lieut. Suvorov, 25th Regiment.
2nd. 150 men, under Staff-Capt. Maslenkov, 26th Regiment.
3rd. 90 men, under Lieut. Vasilevski, 28th Regiment, and 45 convalescents without an officer.

The 4th Hospital Detachment arrived later.

Capt. Geiking, commanding the Hospital Battalion, was also sent to Flat Hill.

During the skilful counter-attack on the left redoubt, Staff-Capt. Belozerov was struck in the head by the splinter of an 11" shell and part of his brain was laid bare. He was borne from the hill in a state of unconsciousness, while his men, who had been encouraged by his example, completed their work. In spite of the numerical superiority of the enemy they drove them at the point of the bayonet from the left redoubt, and captured their flag and sent it to the 5th Regiment headquarters.

At 5 p.m., when the reinforcements came up, the rest of the hill was cleared of the enemy, a result due in part to the energetic action of General Tretyakov, in part to the gallant conduct of the men and officers, and in part to the skilful artillery practice from Forts Nos. 4 and 5, Entrenchments Nos. 4 and 5, Battery Letter D, Red Hill, and above all to that of the quick-firing guns in Liudzyatun village on the left flank.

The artillery commander on Red Hill, Staff-Capt. Kornilovich, 4th E. Siberian Rifled Artillery Brigade, did all he could to assist the infantry, carrying his enthusiasm for his quick-firing guns to the point of laying them himself. That the fire from Red Hill was specially annoying to the Japanese was evident from the fact that on it was directed the fire from several of their batteries. Kornilovich, deeply engrossed in his firing, paid no attention to the shells which were falling within a few paces of him, and continued his accurate fire in spite of the entreaties of his men to go under cover. In the end the gun which he was working was struck by a Japanese shell, and splinters from a broken wheel covered him with wounds, from which he died before reaching hospital. He was at once replaced by Capt. Benua, already distinguished on the 18th May, who successfully carried on the firing and was fortunate enough to escape uninjured.

About 4 p.m. Capt. Nezhentsev and Lieut. Siromyatnikov, observing to the front of Visokaya, noticed dense columns of Japanese reinforcements going up the hill, and opened on them a rapid mixed fire of shrapnel and common shell from their four guns. Again the Japanese could not endure this, and broke in disorder, leaving killed and wounded on the slope.

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In this way the assault was repulsed by the mutually supported action of infantry and artillery.

At the same time the Japanese assaulted Flat Hill, and again they chiefly directed their efforts against the unfortunate section near the dead ground. On this occasion the section was occupied by part of the 9th Company, 5th Regiment, the remainder of the company holding the trenches further to the right.

The Japanese infantry were within 50 paces, carrying on a hand-grenade and rifle fight with the Russians, while their artillery battered the trenches of the whole hill, and especially of this section, with 6″ and 11″ shells and mines. The losses were very great, and in the "unfortunate" section the men had to be taken out and only sentries left. Towards evening the attack took place, and before the sentries could report its approach the section was in the hands of the enemy. The company on the left also evacuated a part of their trench. Seeing this success, the Japanese, in number about a battalion, moved up to the Stony Redoubt and lay down on the glacis, leaving in the captured portion of the trench only a small party with the wounded. The 9th Company, under Lieut. Sirotko, without loss of time charged to the left along the trench and drove out the Japanese, re-occupying the whole of the captured portion of their trench.

At this time there came up two companies of Japanese reinforcements. The 9th Company received them with grenades and rifle fire, and these companies, not expecting such a surprise, broke back to their trenches and opened fire. Part of the 9th Company engaged them with rifle fire and grenades, and the rest of the men faced back up the hill and opened fire on the Japanese, who were lying on the glacis of the Stony Redoubt, at about 200 paces distance from their trench. This fire proved so effective that the Japanese were put into disorder, and small parties and single men began to fall back, but were shot down by the men of the 9th Company. The rest were also harassed with rifle fire and grenades from the redoubt, and at last they could stand it no longer and all broke back to the place where they had crossed the trench. Many volunteers from the 12th Company, 5th Regiment, ran to the assistance of the 9th Company, and all opened a heavy fire, from which many of the Japanese fell on the slope; but a few succeeded in reaching the trench and joined in a bayonet fight, from which about 20 of them eventually succeeded in rejoining their comrades. The losses of the 9th Company amounted to more than 40 men, and the company was replaced by the 10th Company, 5th Regiment.

About 7 p.m. Capt. Stempnevski I. arrived and resumed his duties as commandant.

After several more unsuccessful attacks on Visokaya and Flat Hills the Japanese infantry drew off about midnight, but the artillery as before kept up their fire all night. The Russian losses on the 1st December amounted to from 600 to 700 men.

The continual bombarding of Visokaya caused many casualties. If there had not been constant expectation of infantry attacks, it would have been possible to remove the men during the bombardment; but this could

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not be risked, and consequently great losses were incurred from artillery fire, the men being replaced from time to time from the reserves. In this way the reserves gradually melted away, and requests were constantly coming in for more men and also for grenades. At first whole companies, each of 100 men, were sent up, but even by the 1st December there began to come up small parties of stretcher-bearers, odd men, and convalescents, without rifles and ammunition; these men were very keen to join the fighting, but it was often a matter of question whether they were fit for it, and in fact whether they were of any use whatever.

In the parties from the hospitals were to be found men of various regiments, including sailors and gunners. Each of them had some physical defect; one was so lame that it took him half the day to march some 1½ to 2 versts, another could not use his hand, and a third had lost an eye. Others could hardly move from weakness, due to wounds, exhaustion, or incipient scurvy. The very sight of such fighting men made one shudder!

As the writer was then Regimental Adjutant, all these parties reported to him, and his feelings may be imagined when he had to place arms in the hands of such cripples, and form them into detachments, and send them up to the front. As a matter of fact, the greater part of them he sent to Entrenchment No. 4 and Fort No. 5, as in those works, if the Japanese should advance, three cripples might take the place of one uninjured man, if the latter were urgently required elsewhere. This gave a certain amount of excuse for taking the 1st Volunteer Party, 5th Regiment, from Entrenchment No. 4 on the 2nd December.

General Stessel, at his wits' end for reserves, gave orders to replace the active service rank and file of the bearer companies by town guards, and to form from them the Hospital Infantry Battalion, under the command of Capt. Baron Geikin, 11th Regiment. These men he sent to the Staff of the Western Front as a reserve, and was thus able to improvise 600 men at the expense of all the hands skilled in care of the wounded.

The Japanese continued to pound Visokaya Hill all night with 6″ high-explosive shell, shrapnel, and mines, supplemented with 11″ shell, which the soldiers called "steam engines," and which fell at the rate of one every five or six minutes. The fire was less intense than it had been during the day, but it caused a great amount of damage and casualties. General Tretyakov strove to carry on work at repairing damage and restoring communication in trenches and approaches, personally superintending the work, and by exposing himself in the most dangerous places set an example of courage that urged the men to increased efforts. The name of Ensign Ermakov deserves mention as his chief assistant in this strenuous work.

But however hard they worked the night's bombardment destroyed more than they could repair. Some idea of the intensity of the fire may be gained from the fact that during the 1st December, of 11″ shell alone there were counted more than 1,000, while of 6″ shell and projectiles of smaller calibres all count was lost.

END OF PART I.

F. E. G. SKEY.

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REVIEWS.

APPLIED PRINCIPLES OF FIELD FORTIFICATION FOR LINE OFFICERS.

By Capt. J. A. Woodruff, Corps of Engineers, U.S.A.

This work has been written for the use of the members of the Army School of the Line and Staff College in America, and it is intended to be used with the official textbook on Field Fortification, the *Engineer Field Manual*, Part V., which is constantly referred to for details.

The book would seem to be well suited for the purpose for which it is intended. It is short, logically arranged, and contains (together with the *Engineer Field Manual* referred to) sufficient information to work out ordinary defence problems.

The first chapter deals with general principles, and it is evident that the author belongs to the school which considers that field fortification is all-sufficient, and that the class of works commonly known as "permanent" is unnecessary. He remarks that "positions surrounding important nuclei are usually occupied by permanent fortifications, often supplemented by fieldworks, as at Port Arthur. But examples in field fortification may be found in Plevna, Vicksburg, Petersburg, and Sebastopol." It is undoubtedly true that these are good examples of defences made behind fieldworks, but it must be remembered that there was no choice in the matter, they possessed no permanent works and had to be defended.

Again, discussing the form which points of support should take, the author says that "anything in the nature of a fort or redoubt must always form a more or less conspicuous target, and be certain of receiving a heavy and concentrated fire from the besieger's batteries." Also, "it seems probable therefore that each of the detached points that go to make up a great defensive position would consist merely of a locality or tract of ground rendered defensible by a skilful treatment of its natural features, that is to say, by the provision of simple trenches and parapets."

It is undeniable that a splendid defence has often been made behind pure fieldworks for long periods, but when the superior cover, obstacle, and comfort afforded by the usual type of permanent work is considered, one cannot help thinking that the same troops who made this good defence behind fieldworks would have done better had their points of

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support been permanent ones, or, what is equally important, the number of men might have been reduced. The author very properly points out that siege and field warfare only differ in degree, but this applies also to works of defence. Earth, concrete, and steel are all materials which may be used for giving cover, and only differ in degree. Also it is not necessary that a permanent point of support should take the form of high upstanding works exposed to the enemy's artillery fire and helpless to make reply. The forts at Port Arthur were neither models in design nor choice of site.

An important point, which is always made much of on the Continent, is the value of flanking fire from the points of support over the intervals between them. This is referred to in this book, but receives but little prominence.

The author agrees with the French idea of preparing advanced positions and second lines. There is a great deal to be said on both sides, but the arguments against this course are strong. Money and labour are expended on these positions which otherwise might have been expended on the main position. Garrisons must be told off to them separately, or they will never be held properly, and this generally means weakness all over. Also the moral effect of losing a position on which a great deal of labour has been expended and to which great importance is attached must be great, or else the troops are apt to consider that it does not matter losing a position since there is another behind it. It is a very different thing preparing a retrenched position when it is seen that a portion of the main line is likely to fall.

In a chapter on the design of infantry works the remarks about siting trenches are very clearly expressed. Stress is laid on the necessity for very flat exterior slopes to induce ricochet and to assist concealment. The latter point receives much attention, and the author points out that it is the distant view of a trench which matters; within 400 yards its appearance is immaterial.

As regards the position of obstacles, it is stated that they should be placed from 90 to 100 yards from the parapet. This is considerably further than we advocate. The whole of this chapter is of value.

Some details are given of the men and time required to execute works. It is interesting to compare these with our figures. Rates of excavating are the same. The use of "traction ditchers" is mentioned, and it is stated that some of these can dig a ditch 30″ wide and 3′ deep at the rate of 1 yard a minute. The task for men cutting brushwood is only 60 per cent. of what we give; for small trees it is 50 per cent., while for large trees it is nearly double. For loopholing and notching walls the task is respectively twice and thrice ours, while in the manufacture of hurdles and fascines the time taken is twice and five times what we lay down—and do.

The book concludes by giving three examples of problems, illustrated by maps. These problems are worked out in considerable detail. The maps are rather difficult to read.

J. C. MATHESON.

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NOTES ON R.E. WORKS ON ACTIVE SERVICE.

In these notes, which are full of interest to R.E. officers, the author places before us the results of his wide experience in cantonment building, and to those who were associated with this work in Africa the book will bring back many memories. His African experience predominates the book, but very little ingenuity is required to adapt the general principles and advice to almost any country, and the individual who owns of a copy of these notes, and who is landed in a country and under conditions which no regulations can touch, will be grateful.

In reading the book we must bear in mind the title, and remember that if the designs of roofs and floors are not in accordance with the principles laid down in the usual textbooks, yet for rapid construction and temporary use the buildings have been actually put up and used, and have fulfilled the purpose for which they were built.

Chapter I. Organization and Preparation.—The importance of getting in touch with the civil authorities, the principles of organization, backed up by Bacon, and the necessities for proper accommodation in the works camps are most clearly stated. Hints on bluffing the impetuous heads of departments concerned may be found in para. 12.

Chapter II. Execution of Works.—Method, the personal equation, and protection of the private and public purse is dealt with. The notes on the personal equation are well worth the study of all R.E. officers, who will have to deal sympathetically with other departments at some time during their service. Even under peace conditions the precautions mentioned against the pastime of stealing Government stores and loitering on the works are worth remembering.

Chapter III. Design.—As mentioned above, in this section there are many points on which R.E. builders would join issue with the author. The timbers used in the roofs are light enough to cause apprehension of an early collapse; but we know that they successfully stood the test and performed what was required of them. The gauge of corrugated iron 24—25 can only be used for very temporary buildings. Those of us who saw the huts constructed by the author can understand his note in para. 48, under "appearance." We remember how he could convert a sausage-shaped hut into a dainty bungalow with no extra charge—or nearly so.

Chapter IV. Water Supply, Drainage, and Sanitation.—This is full of useful information, and gives useful hints as to how corrugated iron may be made to eke out a scanty supply of drainpipes, traps, etc.

Chapter V. Miscellaneous.—In many respects regarding the details of construction of hospital huts these notes are not in accordance with the latest decisions, but the general principles are correct. Perhaps, by the next war, the hospital synopsis will be available to correct these notes by.

Portable Huts.—There is, I think, no doubt that the suggestion that these should be made at the base and sent up country is sound. The portable huts on the market that are good, are costly, and the cheap ones are worthless for export.

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Appendix I. Piecework.—This is well worth reading, and gives some very useful information for checking costs, etc.

The book closes with a series of appendices devoted to regulations for sanitation in camps and barracks. A book of plates is provided to illustrate the notes.

N.B.—R.E. officers can obtain copies free from the Chief Instructor, Construction, S.M.E., on remitting 4d. to cover postage.

RETAINING WALLS IN THEORY AND PRACTICE: A TEXT-BOOK FOR STUDENTS.

By T. E. COLEMAN.—(E. and F. N. Spon, 1909. xii.—160 pp. 5s. net).

This little book on retaining walls contains as much of the theory of the subject as most Engineer officers are likely to require to know. Little or nothing being known for certain as to the thrust to which retaining walls are subject, all the theories about it start with a number of assumptions, and the assumptions of even the greatest authorities are not always above criticism. The Author points out (p. 84) that one of Professor Rankine's assumptions sometimes leads to results which are manifestly incorrect, and wisely omits all reference to a theory of another professor, which also in certain cases leads to unsound conclusions. In an example he shows the difference in the results obtained by basing the design of a wall on different theories. He is also careful to point out another point often overlooked, viz., that when a wall is such that tensile stress may be set up in it, it is not the tensile strength of the bricks or of the mortar that must be considered, but the adhesion of the mortar to the bricks. This is always far lower than the tensile strength of the materials, and if the workmanship is inferior, may be very small indeed.

The practical points, being scattered about the book, are not easily referred to. It would be an improvement to collect together into one chapter a few notes on the design of the foundations and the exclusion of water from them, the filling in of the earth behind the wall, the misuse of projecting copings on a battered wall, the advantages of a rough back, bonding, etc., and on the actual construction of brick, stone, and concrete walls.

The book is well illustrated by diagrams, but drawings of two or three typical walls recently constructed, such as the walls built by railway companies in the course of widenings, would have added considerably to its value. As far as it goes however, the book is a good little book and can be recommended.

'A.M.H.'

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NOTICES OF MAGAZINES.

ELECTRICIAN.

July 30th.

NEW TELEFUNKEN METHOD OF WIRELESS TELEGRAPHY (*p.* 617) is dealt with at some length. Two previous articles described the system, and the present one criticizes certain portions of it, and investigates the advantages which are claimed for it. The conclusions are that two genuine improvements in the practical application of wireless telegraphy are brought about, namely, extreme stranding into insulated strands of conductors carrying oscillatory currents to reduce ohmic loss (this theoretical consideration has been advocated for a long time), and the employment of more frequent sparks than are usually used with the singing arc.

SUBMARINE TELEGRAPHY (*p.* 622).—By S. A. Brown.—Part I. deals with (*a*) cables and their capacity; (*b*), use of condensers and inductances to improve signals both in strength and clearness; (*c*), methods of duplexing.

ELECTRIC POWER SUPPLY OF CHICAGO. III. (*p.* 624).—Distribution Methods and System.—In the central office is a large plan on the wall of the whole high-tension system, and from it one or more operators, called "Load despatchers," control, by telephonic communication, the operation of all the high-tension switch gear. All connections when made are shown in the plan. This approximates to the operations of a "train despatcher" in a railway system.

ILLUMINATION (*p.* 634).—The necessity for good lighting is dealt with in a leading article. It is not a question of mere candle-power, but of presenting the light in a suitable form, so as not to damage the eye. It must be particularly borne in mind when metallic filament lamps are substituted for carbon filament.

ENERGY CONSUMPTION OF TRAINS (*p.* 636).—Results of trials on the Midland Railway at Heysham are given, and are, for a level line, 1 mile between stops:—Schedule speed (*i.e.*, average speed *including* stops), 26 m.p.h.; maximum acceleration, 1·91′ per sec. per sec.; consumption, 99·3 watt-hours per ton-mile for all purposes.

It should be noted that to get higher schedule speeds, such as the 30 m.p.h. of the L. & Y. Liverpool to Southport service, the consumption required must be very largely increased.

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August 6th.

ELECTRIC POWER SUPPLY OF CHICAGO. IV. (*p.* 662).—A description is given of the newest station, which has 14,000-kw. turbo-generators, and contains several novel features, which it is alleged put it ahead of any station in existence.

MODERN SUBMARINE TELEGRAPHY. II. (*p.* 669).—The most important item is a description of Brown's drum cable relay, which is the first practical attempt to turn the siphon recorder into a relay.

August 13th.

DETERIORATION OF LEAD CABLE SHEATHS (*p.* 719).—This article gives the following as the general causes for their deterioration :—(1), Mechanical injury; (2), chemical decomposition; (3), electrolysis; (4), vibration; (5), lightning; (6), impurities in lead. Mechanical injuries are most frequent, and there is no way to preserve cables other than to avoid where possible these dangerous conditions. As regards (2) and (3), the remedy is to (*a*) keep damp out of conduits, and (*b*) earth and bond cables wherever necessary.

August 20th.

TYPES OF ALTERNATING CURRENT COMMUTATOR MOTORS BY EICHBERG (*p.* 739).—Motors for railway work are especially considered. Generally speaking, for such work a frequency of 15 $\sim$ per second is advocated owing to commutation trouble in the motors, but the Eichberg motor (as used in L.B. & S.C. Railway electrification) is shown to run satisfactorily at 25 $\sim$ with considerable attendant advantages.

In the Supplement there are some useful advertisements, notably the Simplex Conduits Co.'s new heating apparatus, and various fans.

A. E. DAVIDSON.

ELECTRICAL REVIEW.

3rd September.

TRANSFORMERS FOR METALLIC FILAMENT LAMPS (*p.* 364).—The general considerations as to design are considered. The principal requirements are that there should be no load losses, and the sizes usually used for house wiring should be efficient. This efficiency varies from about 94 per cent. to 98 per cent., according to size and make, etc. Where transformation ratio is 2:1, the use of balanced transformers is advocated. In these the winding is divided into two parts, each of which gives half the voltage of the primary circuit. The low-tension side then resembles a 3-wire system. The advantages obtained are (1) a smaller transformer can be used, reducing the initial outlay, and (2) there is a saving of some of the transformer losses.

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RECTIFIER FOR SMALL POWERS UP TO 240 WATTS (*p.* 371).—The method of operation of this rectifier is based on the fact that, if two secondaries of a transformer are alternately put into circuit, at each half period the induced current in the secondary circuit will be unindirectional. Its chief use is for charging accumulators off an alternating current house supply. On test the loss in the rectifier was 6 per cent., which makes it more efficient than others on the market. Nothing is said as to the time it will run without regulation.

10th September.

ELECTRICITY IN ARMSTRONG'S WORKS (*p.* 404).—Power for the shops was first obtained from plant in the firm's own works, but with increasing demand it was found better to go to the Corporation. The cables are mostly run in the tie rods of the roof. They are held by wood cleats. As spans are short, the weight is evenly distributed. This method (1) keeps the cable out of the way of cranes, etc.; (2), is cheap; (3), allows of rapid installation.

ELECTRIC WATER HEATER (*p.* 415).—This apparatus is designed to store up heat. A small amount of energy is used for a number of hours at a constant rate, thus enabling consumers to obtain energy at a low price per unit. Hot water to the capacity of the heater can be drawn when required.

PRESERVATION OF POLES (*p.* 433).—Poles decay through the action of germs, which attack them from the outside. An American method of preservation is to dig down say 14″ below ground level; clean the lower end of pole; put a layer of Portland cement and sand on the ground; place a jacket of "hydrobestos" round the pole, leaving an annular space of 2″; fill in this space with germicides (hydrated lime and chloride of sodium mixed with coarse sand, and ¼ to 1 lb. of sulphate of copper per pole); and finally put a special cap on the top of the jacket to exclude moisture. The chemicals are dissolved by the natural moisture in the pole, and pass into it by capillary attraction.

MACHINERY BREAKDOWNS IN 1908 (*p.* 438).—According to Mr. Longridge's annual report, the bulk of electrical breakdowns are due to oil, dust, and damp—especially the first mentioned, as when the oil escapes from bearings it is liable to creep over the other parts of a machine. The ratio of breakdowns to machines insured is about 1 in 10. Over 30 per cent. of breakdowns are due to dirt and neglect.

17th September.

ELECTRICITY IN ARMSTRONG'S WORKS (*p.* 443).—Part II. gives conditions under which group drive and individual drive were considered advisable for various machine tools.

HYDRO-ELECTRIC POWER IN CANADA (*p.* 454).—The short descriptions of various existing plants show the enormous amount of power not only available, but utilized.

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RESULTS OF WIRELESS TELEGRAPHY ON THE POULSEN SYSTEM AT CULLERCOATS (*p.* 463).—Denmark was communicated with, 4 kws. being required at the sending station to transmit a message 600 miles. The various parts of the apparatus are mentioned, and the speed of working is given at from 50 to 100 words a minute.

24th September.

It is advocated that coal (*p.* 482) should be bought on the basis of the number of British thermal units it contains, with restrictions as to the amount of ash, sulphur, moisture, etc., allowable.

MURRAY PHOTO PRINTING SYSTEM (*p.* 483).—A description is given of printing in Roman type direct from line, using Wheatstone transmitting apparatus and the Morse alphabet. The advantage lies in the fact that the letters are printed on sensitized paper, and a greater speed of recording can be obtained.

HYDRO-ELECTRIC POWER STATIONS IN CANADA. Part II. (*p.* 518).—The wide use of aluminium conductors for overhead lines is worth noting.

A. E. DAVIDSON.

JOURNAL DES SCIENCES MILITAIRES.

July 15th and August 1st, 1909.

The Russian staff officer—whose impressions of the French manœuvres appeared in the two previous numbers of the *Journal*—has written an account of his experiences at the German manœuvres, which took place in the Metz-Sarrebruck district from September 7th—10th, 1908.

The manœuvre scheme was drawn up by the German attaché to the Japanese Army in Manchuria. The manœuvre area is crossed by a great number of streams, and communications are easy owing to the many roads and railways. The soil, on the other hand, is clay and very sticky in wet weather. The Emperor in person directed the manœuvres, and although the decisions of umpires based solely on the tactical situation were obeyed as orders given by him, important decisions were always communicated to him.

The general idea was that a "French" army had succeeded in invading the country before carrying out its strategical deployment, in order to strike the defender's left flank while the corps composing it were still scattered. This corresponds to the national characteristics, French dash and German method. Neither side knew more than was impossible to keep secret, and cavalry reconnaissance for this reason began the very first day.

The principal event on the 8th was an extraordinary cavalry attack by the six Bavarian cavalry regiments on unbroken "French" infantry, in a

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vain endeavour to neutralize the superior "French" numbers. As this took place in full view of the Emperor, it is possible that it was not entirely on the "German" commander's order.

As the "French" were too successful, the director so altered the manœuvre theme that on the last day a "parade combat" took place, in which the 80,000 combatants were collected in a small area and frontal attacks were made in close order under a heavy fire.

The physical condition of the German officers is good, and they are under very severe discipline. The staff use their knowledge well, and do not interfere with the dispositions of subordinates. The regimental officers do not hesitate to act, but a weak point is the tendency of corps commanders to follow the combat by eye and in the open. There is no jealousy between the various arms, and a strong line of demarcation exists between the captains and the subalterns. The N.C.O.'s are good, especially in the cavalry. They all have maps and know how to use them.

The contemporary German writers all exalt the offensive as the secret of success, and the general reserve is considered the key to the situation. The scheme almost always carried out at the Imperial manœuvres is a frontal attack coupled with the envelopment of a flank.

In defence a corps puts all its divisions (two or three) in line; if an extra division comes up unexpectedly, it is used as a turning force.

There were no night attacks, but most of the preliminary marches to battle were made at night. The troops also bivouacked after dark. March discipline is severe, and marches are carried out in silence; opening out does not occur.

Fire is never opened at more than 1,000 or 1,500 yards. The author only saw magazine fire used against a cavalry attack at 600 yards, and on the last fire position at 200 yards.

Other points noted are that the retreat after a lost action is very well done; the spade is used both on defensive and offensive; the artillery horses are good. Some artillery always accompanies the advanced guard, and when a position has been occupied it is only abandoned on the complete exhaustion of ammunition or men; the cavalry horses are as good as those of the French, and better than the Russian horses. The officers use the ground well and reconnoitre intelligently. Although charges were made against infantry, they were never carried out against cavalry. Dismounted action is not in favour; machine guns have been rapidly increased in number; communications are very good indeed; no sign of automobile transport was to be seen, nor yet of the rumoured grey-green uniform. The German officer is a conscientious workman, but the soldier lacks dash.

Finally, the writer thinks that the nation which can put a general of talent in supreme command, as well as a numerous and well-taught army in the field composed of soldiers of equal individual character to the German soldier, can look forward with confidence to a contest with the German nation.

H. L. Woodhouse.

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MITTEILUNGEN ÜBER GEGENSTÄNDE DES ARTILLERIE-UND GENIEWESENS.

June, 1909.

FRANCE.—*Aerial Cruiser.*—The French War Office has offered a reward of 5,000 francs for an "aerial cruiser" which satisfies the following conditions:—(1). Has a velocity of 50 kilometres an hour. (2). Can stay 15 hours on end in the air. (3). Can carry a crew of at least six persons, the minimum weight of each person being 75 kilogrammes. (4). Can rise to a height of 2,000 metres. (5). Volume of airship not to be greater than 6,500 cubic metres. (6). Dimensions:—Length, 90 metres; height, 20 metres; diameter, 13 metres.

The tests it will have to undergo are:—(1). To make a circular voyage of 500 kilometres in 15 hours, against a wind of 7 metres a second. (2). To do two-thirds of this journey at a minimum height of 1,300 metres.

The Radio-Steering of Torpedoes.—The "torpille radio automatique" of Monsieur Gabet has recently been finished and tried at Le Creusot. It looks like a submarine, and carries a propeller behind it. It can carry 900 kilogrammes of explosive—instead of 90 as heretofore—is 9 metres long, weighs 4,000 kilogrammes, and is directed by means of Hertzian waves. It moves like a small submarine.

AUSTRIA.—*Through Brakes for Goods Trains.*—There are four types commonly used in Austro-Hungary:—

(1). The automatic Vacuum brakes, used on the Austrian State railways.
(2). The Zweikämmer-Carpenter compressed air brake, used on the Palatinate railways.
(3). The Westinghouse brake, used on the Hungarian State railways.
(4). The Knorr brake of the Prussian railways.

Of these, experiments made in 1908 show the first—the Vacuum brake—to be the best. It was tried with trains of 100, 150, and 200 axles—passenger carriages being added to the 100-axle trains, as would be the case on active service. The Vacuum brake underwent the test perfectly

The Zweikämmer-Carpenter system proved unsatisfactory, the same braking—and thus the same retardation—not being applied to each car. Moreover, a constant speed could not be kept down hills.

The Westinghouse brake was very satisfactory, although it does not stop the train in as short a distance as the Vacuum. The addition of an extra valve and pipe renders this scheme expensive.

The Knorr brake (Prussian) was most unsatisfactory, and quite useless on steep inclines.

July, 1909.

BULGARIA.—The engineers have just been reorganized as follows:—

(*a*). Three Sapper Battalions, each of six companies, garrisoned at Sofia, Jamboli, and Choumen.
(*b*). One Telegraph Battalion (three companies) at Sofia.

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(*c*). One Pontooning Battalion (five companies)—of which two for heavy bridges are at Beila, and three for light bridges at Beila, Nikopolis, and Jamboli.

(*d*). One Railway Battalion (four companies) for both railway construction and traffic managing. To this are attached an airship section and an engineer park.

RUSSIA.—Sandbags now form part of the equipment of the infantry and field artillery. Owing to lack of money they are obtained and made by the battalions themselves.

A new manual on fortress warfare has just appeared. In it the phrase authorizing the commander to "ask a council of war, chosen by himself, whether the besieged fortress has reached its limit of resistance or not" is completely left out. To this phrase was largely due the fall of Port Arthur. The expression "fall of the fortress" is replaced by "capture of the fortress." The new regulations lay down that the fortress commander must prolong the defence to the utmost, and remember that every extra day he holds out affects the general situation and final result of the campaign.

OBSERVATION FROM BALLOONS.—It is almost universally believed that it is as easy to observe from a captive balloon, several hundred feet above the level of the ground, as it is to do so from a mountain of equal height, which has no dead ground on any side. This belief is however erroneous; it is easier to observe from *terra firma* than it is to do so from a balloon. The following are the reasons for this:—

(*a*). Not only does the movement of the car, which the slightest breeze suffices to produce, make observations with field glasses extremely difficult, as the object is continually going out of the field, but also inexperienced aeronauts suffer from "aerial sickness," or "air sickness," on account of it.

(*b*). In a strong wind (over 15 metres a second) captive balloons cannot be used; firstly, because they require too many men to hold them down, and, secondly, because the strain on the envelope is too great.

(*c*). The appearance of objects when seen from a height is extremely deceptive. Thus wet meadows look like lakes, and hedges, orchards, bushes, and folds in the grounds are very likely to be mistaken for lines of trenches or for troops. It is indeed only by repeated observations at different heights and under different atmospheric conditions that the nature of such doubtful objects can be ascertained.

It will thus be seen that it is only by continual practice that perfection and rapidity of observation can be attained.

The difficulties are by no means lessened by the large area which has to be observed. Thus assuming the limit of vision as 10 kilometres, the

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visible area = 314 square kilometres, and even if only one quadrant of the circle and objects in it over 3 kilometres from the balloon have to be sighted, the area to be searched is still 71 square kilometres. Moreover, as the boundaries of the quadrant are marked by no hard-and-fast artificial lines on the ground, even an experienced officer will waste a certain amount of time in looking at ground outside his own area.

At manœuvres the use of captive balloons does not show up as favourably as under active service conditions. Firstly, because other reconnoitring bodies are working under more favourable conditions than would be the case in war time, and, secondly, because the balloons are working under disadvantageous conditions to themselves. In peace exercises all scouting parties are endowed with an invulnerability which enables them to go far nearer the enemy than they would do if bullets were singing about their ears. A large number of civilian vehicles, which in war time would not travel about, move on the ground manœuvred over, and it is extremely difficult from the balloons to fix their identity, whereas the horseman can easily approach them and do so. The use of false fronts and sham battery positions to deceive the enemy is now fully recognized. These are however not built in peace practices. In war they could at once be put down as shams when seen from a balloon, as the absence of life or paucity of numbers holding them would at once be noticed. Again, whereas on active service the positions of guns are given away by their flashes and the direction of the burst, in peace the guns are quite invisible.

An interesting example of the value of captive balloons was given at Paardeberg in the South African War, when, after shelling Cronje's imaginary position for five days, the English sent up a captive balloon and discovered both their error and Cronje's camp, with the result that the Boer force was captured, an episode which marked the end of regular and the beginning of the guerilla and blockhouse periods of the war.

Finally, in manœuvres it is common for the observer to be constantly worried by telephone messages, which necessitate his laying his glasses aside to reply to them. This involves a loss of time which in war would not be possible, especially if the enemy took it into their heads to shell the balloon.

Observation from balloons must be carried out by a staff of officers who are trained at it all the year round—a mere course for artillery officers and three to four weeks' practice in several years is by no means sufficient. The results which it is desired to obtain are :—

(1). To discover officers who can rapidly "spot" objects and can keep their glasses on them in spite of the oscillations of the car.

(2). To so train them that the different appearance of the ground does not deceive them

(3). To enable them by training to easily recognize sham positions from real ones.

(4). To teach them never to send in any information about the veracity of which there is any doubt; such information formed from imperfect observation may spoil a whole operation.

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To obtain these results the following programme for the training of balloon officers is suggested:—

Each instructional ascent should last at least half an hour, to enable the observer to get accustomed to the shaking of the car and to find his position on the map.

Exercises to be carried out aloft:—

(1). Judging distances and verifying them from the map.
(2). Rapid orientation of the map, and map reading.
(3). A detailed examination of stationary and moving objects—*e.g.*, to find out the colour, material, number of windows and chimneys of houses, and the composition, number, and direction of march of bodies of troops.
(4). The description of all objects in a given area, about 4 kilometres away.
(5). A description, from memory, of an observation made aloft, and observations from the balloons of any changes made in the area.
(6). Making estimates of the numbers of bodies of troops of all arms moving in a certain area, and the discovery of entrenchments, field depôts, hospitals, etc.
(7). The exact description of a village, the materials of which it is made, the roads leading to it, the most favourable edge for defence, and subsequent verification of the description by a visit to the place observed.
(8). Photographing of the areas near the balloon.
(9). Sketches and panoramas.
(10). Night observations with the aid of searchlights.
(11). Observation of fire by day and by night.
(12). Observation in winter.
(13). The readjusting of maps for the purposes of balloon observations.
(14). The recording on maps and plans any changes made on a piece of ground examined the year before. The changes are to be discovered by comparison of two sets of photographs taken at intervals of one year.

Practical exercises include:—

(1). Manœuvres.
(2). Manœuvres with fortress troops in fortress war exercises.
(3). The observation and correction of artillery fire under service conditions.
(4). Frequent exercises with forces consisting of the three arms.
(5). Last, but not least, free balloon trips as often as possible. These voyages develop to the utmost the powers of observation, feeling of security, and spirit of initiative of the aeronauts.

A. H. Scott.

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NATURE.

FLYING ANIMALS AND FLYING MACHINES (*p.* 247).—Human flight has till quite lately been considered impracticable. No creature the weight of which approaches even one-quarter that of a man has been able to fly. In order that the wings may support the body, their movement must generate a downward current of air, of which the momentum per unit of wind is equivalent to the downward momentum which the body and wings would acquire in the same time under the influence of gravity. This does not necessitate a large expenditure of work. For instance, when a weight is attached to a parachute and is dropped from a height, the speed of descent soon becomes constant. The resistance of the parachute is proportional to its area, and the speed of descent can be made as small as we please if the area is made large enough.

If we suspend an animal from the parachute by a long rope ladder, when the speed of descent is slow enough, it will have no difficulty in climbing the ladder at such a rate that the centre of gravity of the "system" may remain stationary in the air, and this by an expenditure of work which can be diminished indefinitely by increasing the area of the parachute. This is analogous to the hovering of a bird in the air without horizontal velocity during the downward stroke of the wings.

The animal is the only source of power in supporting the total weight of itself and the parachute. The total weight of similar systems varies as the cube of the linear dimensions, while the supporting area varies as the square, and the living power available varies, not as the total weight, but as the total weight less the weight of the supporting wing. If the animal can only produce a certain amount of power per unit weight of body, these conditions lead to an absolute limit to the weight of an animal which can sustain itself stationary in the air. Thus, if no more favourable way of supporting a weight were available than the down stroke of a wing in still air, flight would be impossible for all except the very smallest animals.

As is well known however, the vertical reaction on a slightly inclined plane, moving rapidly in a horizontal direction, enormously exceeds that which it would experience in dropping through still air, and although the proportionalities between the weights and the supporting area still remain, the actual weight supported by a given area increases indefinitely as the horizontal speed increases.

Air friction however fixes a limit beyond which the inclination of the plane to the direction of motion cannot be advantageously reduced. Experiments have shown that this inclination is about 5°, and that then the ratio of the supporting force to the resistance lies between 5 and 7. A knowledge of the best angle of inclination and the ratio of the resistance of the force on the plane at right angles to its path, afford means of determining the possible efficiency. Experiments in this direction have been made on model screws by Mr. R. E. Froude.

Among birds, those which fly continuously seldom have the ratio of weight to wing area much more than 1 lb. per square foot, and in many

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cases, such as hawks and swallows, the ratio is something like $\frac{1}{3}$ lb. per square foot; but whatever the ratio may be, so long as the animal can only give out a limited amount of power proportional to its weight, a definite limit can be given to the size and weight of the body which can sustain itself in flight by muscular action.

The weight of a flock of birds is limited simply by the numbers in the flock, and we have only to suppose the individuals to be connected by a light framework to convert the flock into a flying machine, the wing weight of which is proportional to the wing area. To a certain extent, the biplane flying machine carries out the same idea, but in most of the existing types the weight of the connecting framework must to a great extent neutralize the reduction of weight which should accompany the reduced linear dimension.

It is due to the advent of the internal combustion engine that it is now possible to carry air-borne loads of more than 1,000 lbs. To carry heavy loads with a moderate wing area requires large horizontal velocities, and in such machines as have succeeded the load per square foot generally exceeds 2 lbs. The high velocity requisite is advantageous when the machine is launched and pursuing a straight course, but it adds to the difficulty of starting and stopping, and is a restriction on manœuvring power; that is, it increases the radius of the circle in which the machine can turn. In flying in a horizontal curve, therefore, the normal force must be increased by quickening the engine revolutions, and the fore and aft trim of the wings altered. It requires more power to fly in a curve than in a straight course at the same speed. Exact experiments have yet to be made on the manœuvring capacity of flying machines, and the subject will have to be carefully investigated, also as to intrinsic stability, with ease of starting and stopping.

The Cadastral Survey of Egypt.—By Capt. H. G. Lyons, late R.E. (*p.* 194).—In Egypt, when the present Survey Department was established in 1898, it was found that though vast sums (at least half a million) had been expended upon spasmodic efforts at map making, no work of a permanent nature had been done, and for all practical purposes most of the money so spent might as profitably have been thrown into the Nile, as no system of triangulation or other accurate fixation of points had been carried out. In 1898 this waste came to an end, and the whole work was started upon sound and permanent lines. The result of this is that Egypt now possesses a map of the cultivated area, upon a uniform scale of 1/2500, a possession of enormous value to the agricultural development of this country. An account of a cadastral survey is usually a dry subject to the general reader, but many portions of the present volume, especially the description of old land measures and the method of arriving at the areas of holdings, are extremely interesting.

Surveyors will owe a debt of gratitude to Capt. Lyons and his Staff for the trouble they have taken to place on record the fruits of their experience.

W. E. Warrand.

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NEUE MILITÄRISCHE BLÄTTER.

The possibility, which seemed imminent at the beginning of the present year of an armed conflict between the Hapsburg Monarchy and Russia, lead to an interesting article in the *Neue Militärische Blätter* on the frontier territories of Austria and Russia, and the probable theatre of operations. The area of concentration and base of operations for Austria would be Galicia, and in no case is it to be supposed that with her strong and well-organized army she would act otherwise than on the offensive. She possesses the more concentrated strength and the better prepared forces. Study of military history besides teaches the advantage of taking the offensive, that is to say, the freedom of movement which it gives, and superiority of moral. Austria-Hungary has formed in Galicia two strong fortified places—Cracow and Przemsyl—and the network of railways is constructed to the best advantage under all strategical considerations. Two great lines traverse Galicia—one from Cracow *viâ* Tarnow-Przemsyl-Lemburg to Tarnopol, in the north, and, in the south, a line somewhat parallel with it along the northern base of the Carpathians. Both these main lines are connected with Hungary by not less than six mountain lines over the Carpathians, and these again are connected by a whole network of lines, while not less than nine lines lead right up to the Russian frontier. In view of all this, it must be admitted that Austria-Hungary has procured an excellent foundation on which to construct strategical offensive operations.

Russia has, as everybody knows, for nearly three decades collected large bodies of troops in Poland against Austria-Hungary. These are distributed more or less in two groups:—(1), In the so-called Polish fortified triangle - Warsaw-Ivangorod-Brest-Litowsky; (2), at Kiev, Shitomir, and Berdischew. Between both these areas a huge swampy wooded district extends, almost devoid of towns and roads, and always well-nigh impassable in the spring. The Russian network of railways has been considerably improved in the last 10 years or so, and the extensions have been made with particular regard to strategical considerations. There are however still some large gaps in it, and it is not to be compared to the Austrian frontier.

With regard to her preparedness for war, Russia suffers from the extraordinarily long distances, which cannot be completely bridged even by extensive railway construction. From the strategical line, Kiev-Warsaw, there are certainly some branch lines stretching southward, but hardly to such an extent as to provide sufficient communication to the Galician frontier. Owing to this want of efficient communication, and to the well-known inclination of Russian generalship to adopt a waiting attitude, the writer is led to believe that the Russians will hardly act on an offensive plan. He thinks that if ever a rupture occurred it is not improbable that Russia would act on the defensive in the fortified triangle, and there await the enemy's attack. The time which she would hope to gain in this way would presumably be used in collecting a second great army at Kiev from the interior of Russia.

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This army would then stand on the right flank of the Austrian Army, operating against the fortified triangle.

Even allowing for the advantage gained by taking the offensive, and the assumed tactical superiority of her troops, Austria's task would be no light one. The theatre of war would be very extended, and offers two objectives eccentrically situated, namely, Warsaw and Kiev. Russia's best ally would be her vast size.

If then, the writer concludes, the strategical and tactical conditions offer good prospects for Austria at the commencement of a campaign, it must not be overlooked that Russia, if she wished to carry on the war with tenacity to the bitter end, would have natural allies, which would exhaust her opponents and would ultimately place victory within her reach.

E. G. Wace.

Revue du Génie Militaire.

April, 1909.

Tramways for Animal Traction in Manchuria.—The Russians constructed over 3,000 kilometres of light tramway during the war with Japan. The gauge used was 70 centimetres. The rails were made up in sections of 75 centimetres, 1·5 and 2·5 metres, attached to steel sleepers. Each rail had a hook at one end and a stud at the other. The hooks of one section gripped the studs of the next. Rails and sleepers together weighed 33 kilogrammes per metre. The trucks were mounted on two bogies. Each truck had a floor space of 1·4 × 4·2 metres, and could carry 1,640 kilogrammes. When time allowed the formation level was prepared by digging two trenches 5·25 metres apart, and about 1 metre in depth, and ·7 metres in breadth. The soil from these trenches was thrown towards the centre, and on it the sleepers were laid. In marshy ground fascines were laid down first and the soil thrown on the top. Nine trains a day were run in each direction. The passenger trains consisted of three covered trucks, and seven trucks for baggage; they travelled from 8 to 12 kilometres per hour. The goods trains averaged 4 to 6 kilometres per hour.

Aerial Sustaining Propellers.—An investigation of the theory of aerial propellers. A propeller with a very low pitch is theoretically the most effective, but the lower the pitch the larger must be the propeller, and the higher the speed of revolution to develop a given thrust. A large propeller constructed on the Louvre system appears to offer the best results.

May, 1909.

The Engineers at Casablanca.—An account of the organization of the engineer services in Morocco during 1907 and 1908.

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TRAMWAYS FOR ANIMAL TRACTION IN MANCHURIA.—A continuation of a previous article. An account is given of the lines of tramway that were laid down to serve the Russian positions at Liao-yang, Mukden, and Sypingai. These lines enabled the Russians to mount their heavy guns at a distance of 15 kilometres from the railway, and finally to remove them during the retreat.

June, 1909.

THE ENGINEERS AT CASABLANCA.—A continuation of a previous article. The French constructed stone forts and blockhouses for their advanced posts; their larger posts and the standing camps were surrounded by an ordinary earthen parapet, traversed at intervals, and with a shallow ditch in front.

A pile bridge, 620′ long, was constructed over the Neffi-fick. Trestles could not be used, as the bottom of the river was shifting sand. A flying bridge was used for crossing the Oum-er-Rebea. The passage of this river was first made by means of a boat constructed out of the bodies of two Moroccan carts, over which a tarpaulin was lashed. This boat was put together in 15 minutes.

A tramway of the Decauville pattern was laid between Casablanca and Bu Reched, a distance of 40 kilometres. The gauge was half a metre. Each truck carried a ton, and was drawn by one mule. The rails were laid on a stone-ballasted track, 2 metres in breadth. The ballast was well consolidated to form a roadway for the mules. At one side of the track a footway was left for the driver. The normal traffic amounted to a convoy of 40 trucks each way per day.

TRAMWAYS FOR ANIMAL TRACTION.—A continuation of previous articles. These articles are founded on an account of the Russian tramways in Manchuria, which appeared in the *Eenzhenernee Zhoornal*. A transcript of this article has been published already in the *R.E. Journal*.

July, 1909.

THE ENGINEERS AT CASABLANCA.—A continuation of previous articles. Semi-permanent barracks were constructed for the French troops. These consisted of wooden huts, roofed with corrugated iron. The walls were lined on the inside with ruberoid or tarred paper, and ceilings were made of the same materials. The huts for the European troops had wooden floors, raised 3′ from the ground, and were surrounded by a 6′ verandah. The Foreign Legion and the artillery constructed their own barracks, under the direction of the engineers. The engineers constructed barracks for the remainder of the troops. At Ber Rechid the huts were built with mud walls and corrugated iron roofs.

WATER STERILIZATION.—The mercury vapour lamp gives out a light that is very rich in ultra-violet rays. It has been found that microbes exposed to these rays are quickly destroyed. In this way water may be sterilized in the course of a few minutes. It is probable that the process will be adopted for water purification.

J. E. E. CRASTER.

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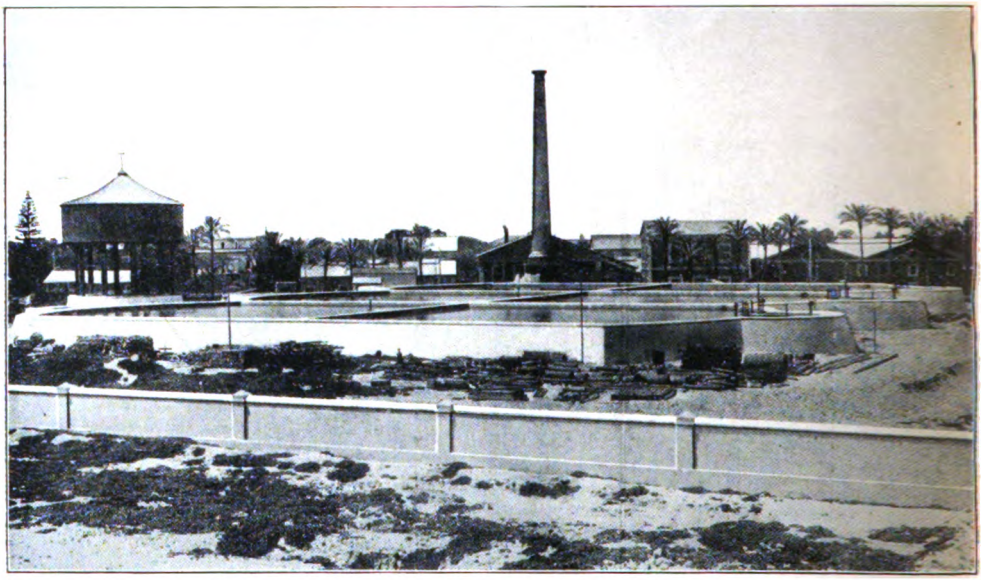
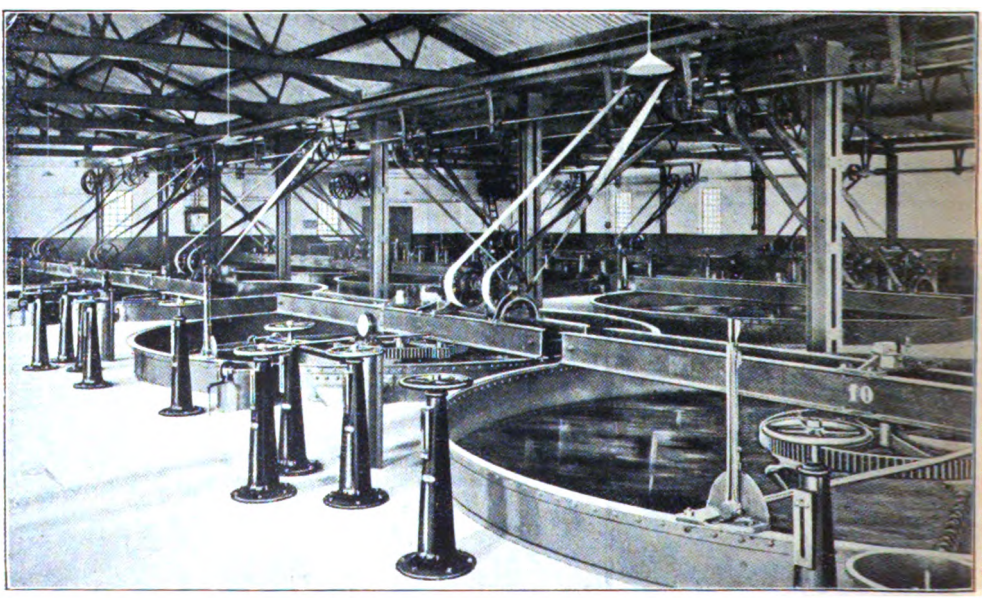


Settling Tanks and Wash-Water Tower.



Interior of Filter-House.

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THE WATER SUPPLY OF ALEXANDRIA.

By CAPT. D. M. F. HOYSTED, R.E.

THE usual source of drinking water in the land of the Pharaohs is the Nile, which, besides being one of the most historical rivers in the world, is also one of the most polluted, and has consequently been responsible for an incredible number of cases of fatal or dangerous illness.

Alexandria is the first town in Egypt to be supplied with an efficient and up-to-date system of filtration for its water supply, and the inauguration of this work in 1905 formed an epoch in the advance of science in the almost unchanging East. Such an innovation was naturally preceded by many years of discussion, until the Jewell Expert Filter Co. of New York sent a representative to Egypt who offered to instal a model plant, so that the local councillors and engineer might actually see the results which the firm was prepared to obtain for them. This appeal to the senses of the uninitiated among the committee at once overcame all opposition and reluctance, and the order for nearly £80,000 was placed with the American Company. The final convention was signed in July, 1903, the work to take two years.

The Jewell system of sand filtration presents many great advantages over the slow sand system which had previously been considered. Only about one-sixth of the area is required for the same output, the cleaning and washing of the filters is carried out mechanically, and without any workman having to come in contact with the filtering sand. Anyone acquainted with the insanitary habits of natives will appreciate this point.

The main pumping station and filtration works of the Alexandria Water Company are situated on the main road to the suburbs of Ramleh and Aboukir, and are on the outskirts of the town.

This station has to supply filtered water for a population of half-a-million people, and the daily consumption varies from $4\frac{1}{2}$ to 8 million gallons, the maximum amount being required during the hot weather when the Nile is at its lowest level, and consequently in its worst state for purification.

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The filters are contained in a covered house, and protected from sun and dust, and in addition there is a regulator for the speed of filtration and pressure, the flow being absolutely constant during the entire run.

Alexandria Water Company.—From the river Nile at Atfeh, near Rosetta, there runs a waterway called the Mahmoudieh Canal, constructed in 1819 by Mahomet Ali. It is 45 miles long, and is used not only for irrigation, but as a means of traffic between Alexandria and Cairo and the intermediate towns and villages, besides being practically a carrier of sewage. From this the water is primarily obtained, and, to obtain sufficient head, it is pumped from it into the company's private waterway called the Farkha Canal, whence it flows direct into three collecting wells at the main pumping station.

Thence it is raised by low service pumps and delivered through a 30″ main to the settling tanks, where it is allowed to rest for at least 6 hours under the influence of a solution of sulphate of alumina, which is injected into the centre of the 30″ main between the pumping station and the settling tanks to allow of thorough admixture.

Coagulant Feed.—This coagulant feed is arranged systematically from the coagulant room in the main building. The sulphate of alumina is hoisted from the store room in the basement to the coagulant room, is weighed carefully, and is carried as required by a small over-head transporter over the coagulant tanks.

The dissolving tanks are made of battens of Cypress wood 4″ wide, as it was found that this wood withstands the action of the chemical very well. These are held together in the form of a cylinder by steel bands without any arrangement for securing close joints. The sides are notched into the bottom.

The chemical is placed in shallow wooden trays with open slat bottoms through which the water rises to dissolve it. There is also a small steam compressor supplying air under pressure for stirring up the solution.

All pipes and fittings are of vulcanized rubber. The strength of the solution is frequently tested before it passes from the coagulant room, as it varies somewhat according to the condition of the water and to the time allowed for sedimentation. Under usual conditions with 6 hours for sedimentation, an admixture of from 15 to 22 parts by weight of sulphate of alumina per million parts of water to be treated, gives excellent results both as regards clarification and bacteriological purification.

Settling Tanks.—There are three settling tanks, each designed to hold nearly a million gallons. At one end common to all three, and connected to each by a 24″ pipe, is a circular distributing basin

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containing about 50,000 gallons, into which the whole of the unfiltered water is pumped.

Sluices are provided to enable any tank to be emptied and cleaned independently, and at the inlet of each settling tank there is a semi-circular basin, of 11′ radius, communicating with the settling tank at the bottom.

Each tank is further divided by two masonry walls 2′ thick, one acting as a weir, with a sluice for cleaning purposes only, and the other —the furthest from the inlet—as a baffle plate, being provided with eight openings at the bottom. The outer compartment is provided with a masonry outlet weir, over which only the top film of water passes to the semi-circular outlet basin (similar to the inlet basin), whence it flows to the filter house through a 30″ sluice valve, by a 36″ main.

In addition to this masonry outlet weir, there are two cast-iron adjustable weirs 9′ in length, working in gunmetal guides. Under normal conditions these are maintained at the same level as the masonry weirs, but they can be lowered 12″, until the engine attendant has had time to increase the flow of the water into the settling tanks, in the event of the water becoming low in the settling tanks through a sudden draw-off in case of fire or other unusual occurrence.

Preparation of Site.—In preparing the site for the foundations of the settling tanks and other reservoirs, it was found that practically the whole area was undermined and honeycombed with disused wells and culverts, which had probably been used for the water supply of some former city of Alexandria. It was considered therefore that the best way to attain the desired stability was to flood the entire area, and a temporary 16″ pipe was laid to the centre of the work, and about quarter of a million tons of water was poured upon it. Considerable subsidence at once became evident, and for a month all such holes were filled in from time to time with earth, until no further settlement took place, the water standing at an average depth of 2′.

Then, after the soil was more or less dry on the surface, the whole area was rolled with a 16-ton steam roller, producing a greater pressure per square foot than the soil would be subsequently subjected to by the weight of masonry and water in the tanks. Hydraulic cement concrete was used throughout in construction in following proportions:— Lime and Pozzolana (Santoria) mixed in proportion of 1 to ¾, 2 parts; sharp washed and screened sand, 6 parts; Portland cement, 1 part. The substance of the concrete consists entirely of ancient broken pattern (Chakf), which is found locally in immense quantities, and which is particularly well suited for concrete work on account of its flat sides and sharp angular edges, which afford an excellent band.

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The lime and Pozzolana mixture was ground in edge runners. The mixing was carried out in the French method; the Chakf was measured out on mixing tables, about $13' \times 7'$, double boarded to prevent leakage, and the mortar, having been previously mixed in a pugmill, was added in a wet state. The whole was, before being used on the work, throughly mixed by hand labour, at that time comparatively cheap in Egypt.

The inside of the settling tank was rendered with two layers of cement plaster, the first about $\frac{1}{2}''$ thick and composed of 3 parts sharp sand to 1 of Portland cement, the surface being left rough as a key; the second about $\frac{1}{4}''$ thick and composed of equal parts of the same components.

The whole surface of the bottom of the tank was lined with a $\frac{3}{4}''$ layer of bituminous asphalte, so as to render it absolutely water-tight, this being in turn covered with a $2''$ layer of fine cement rendering as a protection against damage when cleaning. The inside surfaces of all walls were further treated with a solution of soap and water, followed by a solution of alum and water, so as to entirely close up the pores of the cement.

Filters.—Each filter (of which there are 18) is $17'$ in diameter and $7'$ in depth, and contains $3'$ of filtering sand supported on a layer of fine gravel. Below this is a cast-iron header about $8''$ in diameter, which passes through the skin of the tank at the bottom and forms the outlet. From this header radiate a number of W.I. branch pipes plugged at the outer extremities, both the header and the branch pipes being buried flush in concrete.

These branch pipes are tapped along the upper surfaces at about $6''$ intervals, and provided with small brass screens standing vertically above the concrete base. There are 900 of these screens, and they take the whole of the filtered water as it passes down through the filter, whilst they leave practically no space in which water might remain and stagnate.

The filter proper is surrounded by an outer shell, leaving a $5''$ annular space all round through which the settled water (*i.e.*, water which has passed the settling tanks) rises and flows slowly into the filter along the whole perimeter. After passing through the filter and out of the $8''$ outlet, the filtered water flows through an automatic Weston Controller, by means of which the effluent is automatically kept constant and the working pressure regulated.

The filters are washed daily, the washing operation being controlled by one man, and being extremely simple and only occupying six minutes in all. The inlet and outlet valves are closed and the wash-out valve which drains the annular space is opened. A wash-water valve is then opened, admitting filtered water—under a head of pressure from a special washout tank—into the main outlet header

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pipe, whence it rises through the 900 screens through the bed of sand.

The whole of the filtering skin is throughly churned and broken up by the pressure of the rising water, and the mud and other impurities are swept up over the rim of the filter shell, and are carried away through the annular space and the washout valve to the main drain. At the same time a revolving agitator—consisting of a large circular rake—effectually stirs up the filtering sand to a depth of 2′ 6″. The sand alone remains behind during this upward rush of filtered water, because of its greater specific gravity. The washing is considered complete in five minutes, by which time the wash water running over the annular ring has become clear. The valves are then closed and the unfiltered water allowed to rise to its normal height. The first effluent is run to waste for 10 or 15 minutes, as may be found necessary, so as to remove any slight turbidity which may be left in the filter after washing, and subsequently it is admitted through to the delivery pipe into the clear water reservoir situated below the filters.

Wash-Water Tank.—The necessary head for washing is provided by a circular steel tank, 34′ in diameter by 10′ in depth, mounted on a strongly braced steel structure, and containing 50,000 gallons of filtered water about 40′ above the tops of the filters. It is connected to the wash-water valve of each filter by a 12″ pipe.

The water is supplied by two 10″ centrifugal pumps, and the tank is covered in at the top, and has a covered gangway all round it to protect the water from the effect of the sun. The exact height of water is recorded in the engine room by a Kent electrical recording instrument fixed on the wall.

Clear-Water Reservoir.—The clear-water reservoir under the filters is divided into three compartments, so that any one may be shut off for cleaning purposes without disturbing the remainder. The bottom is made in the same way as that of the settling tanks. The whole reservoir is covered in with expanded metal and cement concrete, supported on steel girders, a sufficient number of inspection traps being provided in the covering. This covering is, in turn, made impervious to water, clean or dirty, by a $\frac{3}{4}$″ layer of asphalte. Two additional and similar reservoirs are situated on the other side of the pumping station.

The three reservoirs contain $1\frac{3}{4}$ million gallons of filtered water, about a quarter day's supply for all purposes. Above the engine room there is a chemical laboratory equipped with every requisite for the bacteriological examination of the water and for the chemical examination of the coagulant feed. The water is carefully examined and tested every day; never since the first month of the working of the

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new filters has the percentage of bacteria removed been less than 98, while the effluent is considered pure enough for human consumption. This is a great feat to have achieved, with such comparative ease, in the East where pure water is so very difficult to obtain.

I am much indebted for this information to H. R. C. Blagden, Esq., M. I. Mech. Engineers, the Manager and Chief Engineer of the Alexandria Water Company, who very courteously conducted me over the works.

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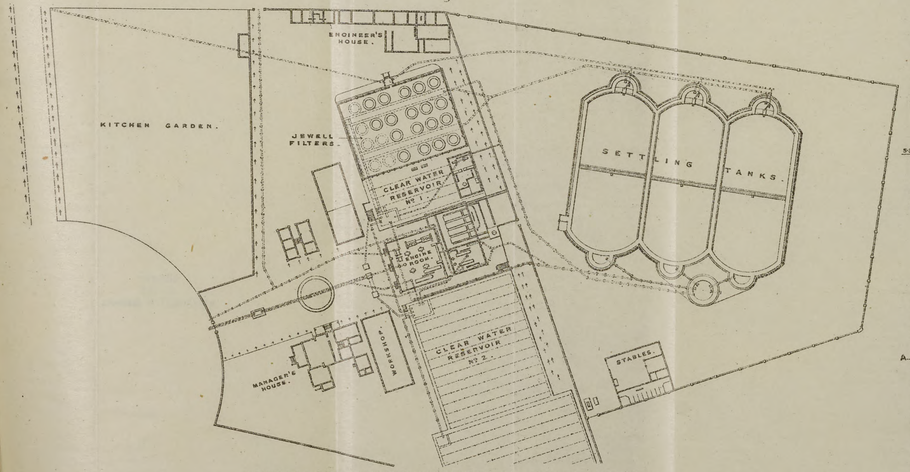
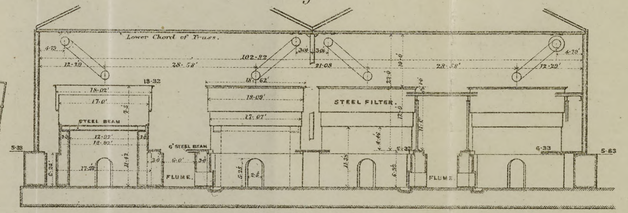
FILTRATION – WORKS: ALEXANDRIA WATER – SUPPLY.

Fig: 1.

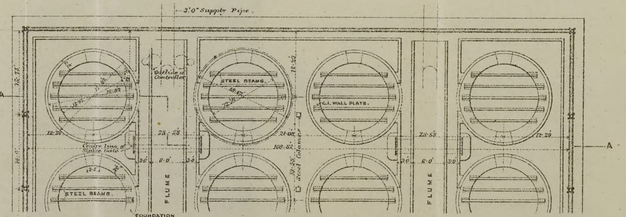


GENERAL ARRANGEMENT OF WORKS AT PORTE ROSETTE.

Figs 3.

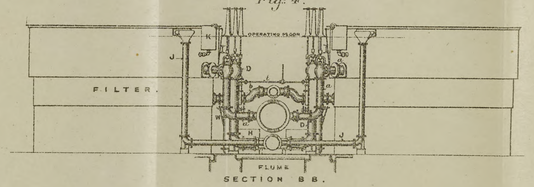


SECTION A A.

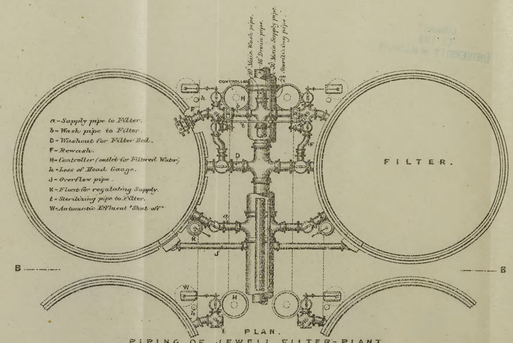


PLAN OF FOUNDATIONS.
FILTER – HOUSE.

Figs 4.

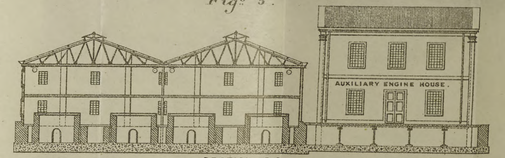


SECTION B B.


a – Supply pipe to Filter.
b – Wash pipe to Filter.
D – Washout for Filter Bed.
F – Rewash.
H – Controller (mulled for Filtered Water).
h – Loss of Head Gauge.
j – Overflow pipe.
K – Flange for regulating Supply.
L – Sterilizing pipe to Filter.
We determine Effluent "Chart. 16".
FILTER.
PLAN.

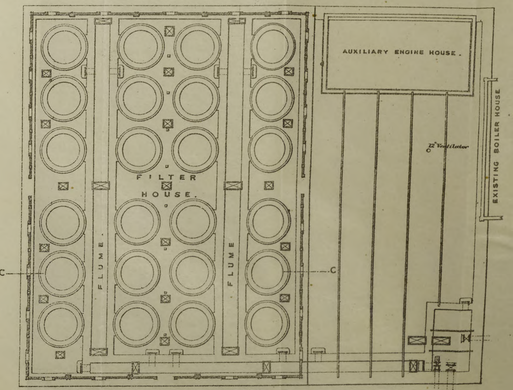
PIPING OF JEWELL FILTER-PLANT.

Figs 5.



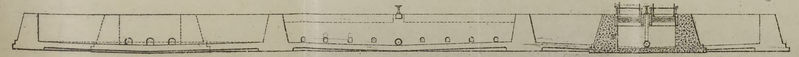
SECTION C C.

SECTION THROUGH OUTLET BASIN OF CLEAR WATER RESERVOIR.



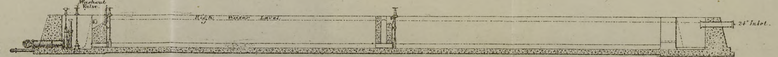
PLAN.
JEWELL FILTER-HOUSE AND AUXILIARY ENGINE-HOUSE

Figs 2.



CROSS SECTION SHOWING INLET. CROSS SECTION SHOWING MIDDLE WALL. CROSS SECTION OF OUTLET BASIN.

SECTIONS OF SETTLING-TANKS.



LONGITUDINAL SECTION.

SCALES.

Figs 1. ..... 1 Inch = 100 Feet.
Feet 100 0 100 200 Feet.
Figs 2 and 3. ..... 1 Inch = 20 Feet.
Feet 10 4 0 20 30 40 60 20 Feet.
Figs 4. ..... 1 Inch = 16 Feet.
Feet 32 8 0 16 30 40 Feet.
Figs 5. ..... 1 Inch = 8 Feet.
Feet 32 0 8 32 Feet.

H.R.C. BLAGDEN.

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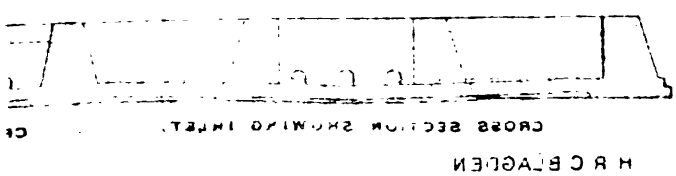

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NOTES ON "c" AND "d."

By CAPT. J. E. E. CRASTER, R.E.

I.—NOTES ON "*d*."

ALTHOUGH the following notes are intended to suggest a course of study which should enable a candidate to pass the examination in "*d*" with a good margin to spare, they can hardly be curtailed with safety.

A candidate should start work some six months before the date of the examination. The first thing to do is to read over all the paragraphs in the *King's Regulations* that bear on the subject, and then to obtain the papers set at the last three or four examinations, so as to study the questions set and the examiners' comments on the answers. (The examination papers are bound up with the examiners' remarks, and are published officially).

Most candidates will find that tactics require longer preparation than the other subjects, chiefly because skill in tactics depends upon the possession of military instinct, and instinct is a quality which grows but slowly. If time is available, it is best to begin by reading an easy book on the art of war—Hamley's *Operations of War*, or *Modern Strategy*, by James—and then to read through the *Field Service Regulations*, Part I. When this has been done, the candidate will have some theoretical knowledge of the subject. In order to learn how to put this knowledge to practical use, he should work through some tactical exercises. Griepenkerl's *Letters on Applied Tactics* give a number of simple problems, with their solutions. A point should be made of writing the orders in full for each problem, otherwise little benefit is derived from the exercises.

Griepenkerl's solutions, however, do not always follow the rules laid down in *Field Service Regulations*, and it is better therefore always to read over the part of the *Field Service Regulations* that deals with the problem in question, before looking at Griepenkerl's solution. It is in outpost problems in particular that Griepenkerl's practice differs from ours. It is also advisable to work out several schemes against time, and to get a friend to criticize them.

After tactics, military history will require the most preparation. As a preliminary to the study of the particular campaign selected, it is useful to read a little of the general history of the period. Sanderson's *Outlines of the World's History* will give all the information required in a few pages. This book will be found in most

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reference libraries. On most campaigns a number of books have been written, but as a rule there is one which is recognized as a standard work. This book will generally be sufficient for requirements, but if other works can be obtained from a library, the study of the campaign should not be confined to one book only. The official accounts are usually too full and detailed to be of any use for examination purposes.

Throughout the examination a good deal of importance will be attached to the *manner*, as well as the *matter*, of the answers. Even if a candidate has not a distinguished literary style at his command, he may at least avoid grammatical errors, faults in spelling, and slang. The history paper offers the greatest scope for the exhibition of literary style.

Before reading up Military Law, it is advisable to see that the copy of *King's Regulations* is amended and up to date. *Military Law Made Easy*, by Banning, is the best book to study, and all references to the *King's Regulations* and *Manual of Military Law* should be verified. The papers at the end of the book should also be worked through, and the answers compared with those given by Banning.

Organization and administration together form a very large subject, and it is impossible to prophesy which part of it the examiners will select. The books published by Banning and Brunker are both good, and there is little to choose between them. Care should be taken to obtain the latest editions, and to see that they are corrected up to date. No doubt many of the questions in future examinations will bear upon the new *Field Service Regulations*, Part II., and candidates should be thoroughly acquainted with this book.

Military Engineering and Map Reading should not require much study by R.E.'s. After reading through the two manuals once, candidates should be able to judge which are their weak points in these subjects, and they can then concentrate their attention on these points to the exclusion of the rest.

The following is a list of books required in preparing for the examination :—

Field Service Regulations, Parts I. and II.
Manual of Military Engineering.
Manual of Map Reading.
King's Regulations.
Letters on Applied Tactics—Griepenkerl.
Operations of War—Hamley ; or
Modern Strategy—James.
Military Law Made Easy—Banning.
Organization Made Easy—Brunker ; or
Organization Made Easy—Banning.
A Standard Work on the Military Campaign.
The Manual of Military Law.

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2.—NOTES ON "c."

The examination in "c" comprises three subjects :—

(1). Practical Map Reading, Field Sketching, and Reconnaissance	100	marks.
(2). Practical Military Engineering	100	„
(3). Practical Tactics	200	„
Total ...	400	marks.

To qualify it is necessary to obtain ·5 of the maximum in each subject, and ·6 of the total.

The examination is usually conducted in the following manner:— On the first day the candidate is required to make a sketch of about a square mile of country, and to write a reconnaissance report, or reports, in connection with it. The time allowed is six hours. Out of a total of 100 marks for this day's work only 30 are allotted to the sketch, the remaining 70 being given for the report. The sketch is therefore a matter of minor importance, and only a short time should be devoted to it.

A common mistake is to attempt to make an accurate and elaborate plane table or prismatic compass sketch on the ground. This is almost an impossibility. In England the country is so enclosed, and there is so much detail to be supplied, that the most rapid sketcher can hardly map a square mile in six hours; but even if he completes his sketch, he will find he has no time left to write his report, and it is the report that pays.

Each candidate is provided with a $\frac{1}{2}$-inch map, and it is advisable, and permissible, to make an enlargement of this to form the skeleton of the sketch. Fences and contours should be added afterwards on the ground. An enlargement may be made accurately and quickly by ruling the map into squares, as described in the manual of field sketching, but in order to avoid marking the map it is better to employ a sheet of tracing paper ruled into small squares, which can be fastened over the map with drawing pins. A small sheet of glass with cross lines cut on it is a further refinement. As the total area on the $\frac{1}{2}$-inch map will measure less than 1 square inch, a very small piece of glass will suffice.

It is advisable to have a small bottle of *waterproof* Indian ink at hand, so that if time allows the sketch may be inked in. Coloured chalks should not be used till the sketch is otherwise complete, as the chalk lines are easily blurred. In finishing up the sketch the following details are often forgotten :—Heading, scale, north point, destination of roads, nature of crops, signature, place and date.

The report should be written in the form laid down in *Field Service Regulations*, Part I., paragraphs 9, 12, and 16, and, in order that the

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candidate may be able to render an exhaustive and accurate reconnaissance report, he should study in particular paragraphs 96 and 130.

The second day of the examination is usually devoted to tactical and engineering problems on the ground. From 10 minutes to half an hour is allowed for deliberation on each problem, and the answer must be given *vivâ voce*. The place is very easily lost on a small scale map, and it is therefore advisable to mark the position referred to in the problem with a pin. Candidates are expected to use the field service pocket-book in answering questions. The index of the pocket-book is very incomplete, and it is preferable to refer to the table of contents at the beginning of the book.

In order that an officer may be prepared to rapidly solve tactical problems, he must have a certain amount of preliminary practice. This may be obtained by working through a book of tactical schemes, such as Needham's *Solutions of Tactical Problems*. Griepenkerl's book is good except as regards outposts. Writing orders also requires practice, otherwise it will be found that some important detail—such as the number of the order or the time of despatch—has been omitted.

The most difficult point that arises is the choice of an artillery position. As a rule the guns are placed too far forward. If a candidate must choose between a forward position and one that seems to him too far to the rear, he will generally be safe in selecting the rearmost.

As regards practical Military Engineering, the candidate should be skilled in knotting, lashing, and field geometry; there is little else that he can be asked to do with his own hands. The remainder of the engineering questions must be answered *vivâ voce* or by means of a hand sketch. The *Manual of Military Engineering* should be followed in answering all questions. Originality is not required.

Questions on the *Manual of Map Reading* are easily answered if the book has been studied beforehand.

Captains who have not got a certificate are required to pass a riding test. This is not a very formidable affair, but if a candidate has not ridden for some time, he should certainly procure a horse and go out a few times to get himself into condition. Trotting along a hard road without rising is the best practice for the riding test.

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A BRUSHWOOD GIRDER BRIDGE.

By Capt. J. E. E. Craster, R.E.

During the fieldworks course of the Survey Companies this year, a bridge of 18′ span was constructed entirely of brushwood to carry infantry in single file. The road-bearers consisted of two lattice-work girders 20′ long; the roadway was made of hurdles laid directly on the upper booms of the girders. Each boom of the girders consisted of two horizontal rods laid side by side. The diagonal and vertical struts and ties, composing the webs of the girders, were single rods. The ends of the diagonal and vertical rods were placed between the two rods that formed the boom, and the whole were tightly lashed together with wire. The diagonals were lashed together at the point of crossing.

When the two girders were complete, they were braced together at every 5′ with horizontal and diagonal ties, lashed to the inner sides of the booms. Finally the hurdles to form the roadway were placed on the upper booms and lashed to them.

The completed bridge weighed under 400 lbs. It was carried down to the water and placed in position by four men. The deflection in the centre, when it was fully loaded with 13 men, was about 4″. This weight was equivalent to 100 lbs. per foot-run.

At the inspection held by the Inspector of Royal Engineers the bridge was finally tested to destruction. Under the weight of 21 men the lower booms crushed at one of the points of support. This was due to the girders being placed on round transoms. Had the weight been properly distributed over flat transoms, there is no doubt that the bridge would have stood a much heavier load.

The largest pieces of brushwood used in the bridge were $1\frac{1}{2}$″ pickets.

Before putting on the wire lashings the pickets should be barked and slightly notched at the point of lashing, otherwise the lashings will give through the bark stripping. The quickest and surest method of making wire lashings is to take one, or at the most two, complete turns, and then finish off by twisting the ends together. Continue in this way till there are six or eight complete turns. If frapping turns are necessary, they may be put on in the same way.

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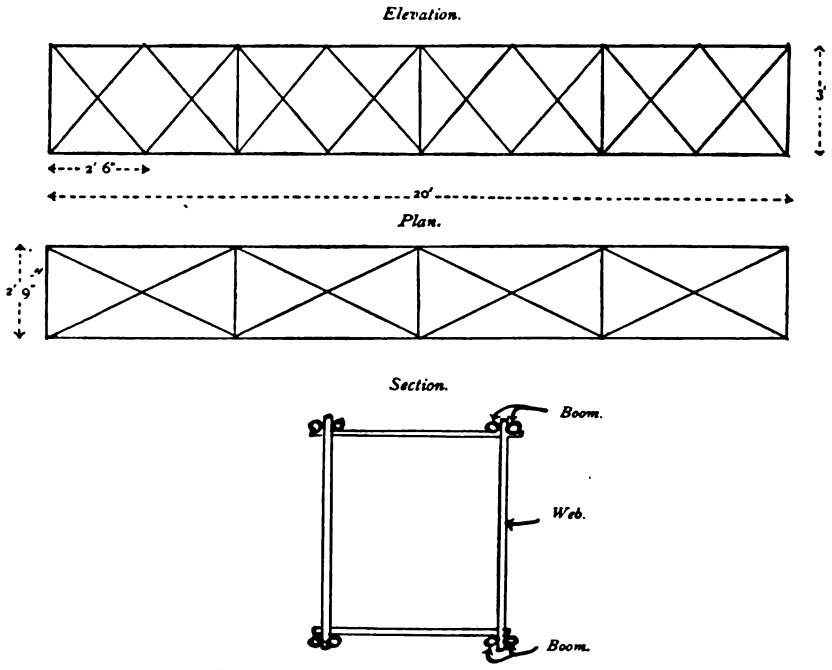
The principle of brushwood bridges is capable of considerable development. There is no reason why a bridge of 30 or 40′ span to carry infantry in fours should not be constructed entirely of brushwood.

Brushwood Lattice Girder Bridge.



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NOTES ON BLAST TESTS.

By MAJOR C. H. FOOTT, ROYAL AUSTRALIAN ENGINEERS.

IT being necessary to construct a searchlight emplacement at a point within the arc of fire of one of the 9·2″ guns mounted at one of the forts in Australia, the question arose as to the effect of the blast from the gun upon the buildings, stores, and *personnel*. In order to gain information on this point, a galvanized iron hut, 6′ square, 7′ high, with the seaward side 3′ 6″ high, was erected at a point within the peace safety arc of the gun.

As it was impossible to fire the gun in the direction of the selected site for the real emplacement, owing to settlement on the opposite shore, a seaward site was chosen for the "dummy" emplacement. The site coincided exactly with that of the real emplacement as regards the configuration of the ground.

Inside this "dummy" emplacement the following stores were placed :—Projector, 90 c.m., Mark I., with glass door ; two glasses brimful of water, one on the floor, one on a flimsy wooden case ; three or four small blocks of deal standing on end.

The mirror and lamp were removed from the projector, and sheet iron was bolted to its back to fill up the open end thus left.

The projector was mounted on a large case, to represent the pedestal. In order that, whatever happened, there would not be a missing projector as a result, it was lashed to the pickets of the permanent entanglement. This proved a needless precaution.

Four rounds of plugged shell with full charges were then fired, the gun being trained in the direction of the projector hut. The first round was fired at an elevation corresponding to 4,000 yards, and blew some sand and grass on to the top of the hut, which successive rounds did not dislodge. No effect whatever was produced on the interior of the hut or its contents—the water was not spilt nor the wood blocks overturned.

Rounds were also fired at 3,000, 2,000, and 1,000 yards, but failed to produce any effect.

The conclusion arrived at was that a reinforced concrete emplacement, with an earth bank on the side nearer the gun, would be safe from blast effect.

During the trial the weather was fine, clear, light breeze blowing at right angles to line of fire ; barometer, 29·90.

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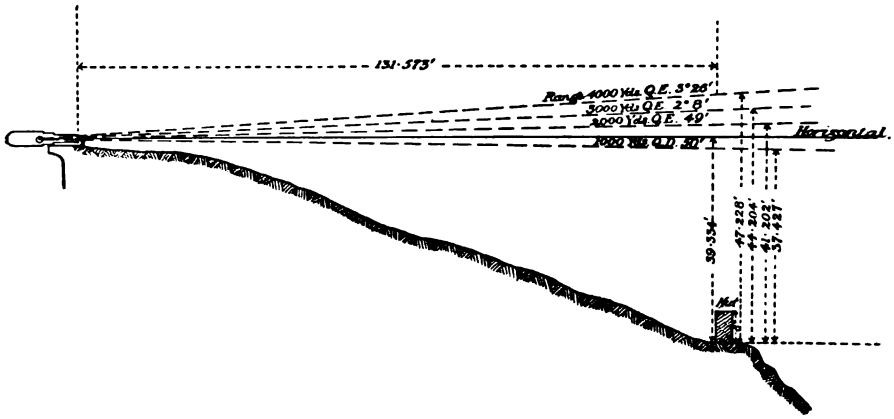
A diagram of the vertical angles and horizontal and vertical distances is attached.



Experimental Firing.—Four rounds fired from 9·2 B.L.H.P. Gun over Temporary Projector Hut.

Charge, 164 lbs. Prism Brown. Weight of Projectile, 380 lbs.

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THE ARRIVAL OF THE AEROPLANE.

By Colonel F. G. Stone, *p.s.c.*, R.A. (*Member of the Aeronautical Society of Great Britain*).

At Blackpool, on October 22nd, 1909, Hubert Latham demonstrated, to the satisfaction of the most exacting critics, that the aeroplane can ride out a gale of wind; in doing so he has established the claim of the "heavier-than-air" machine to be considered seriously in connection with its employment in military operations. To those who realized the true significance of the wonderful spectacle of a man, in a man-made machine, fighting the wind like a seagull, this performance more than compensated for the generally disappointing character of the Blackpool meeting. For here at last it was proved that a well-constructed aeroplane, correctly designed, in the hands of an experienced and skilful pilot, is not liable to be blown over sideways through loss of lateral stability, and can safely cope with a wind blowing at a rate equal to its own normal speed, without any danger of losing longitudinal stability. Latham declared that Rougier on his Voisin machine and Paulhan on his Farman biplane were equally secure from loss of lateral stability; and further, that he was confident that if he had an Antoinette which would travel at 70 miles an hour, he could safely cope with a wind blowing at the same rate, flying freely in every direction.

At 1.50 p.m. Latham made his start; the force of the wind, as registered by the anemometer, was 24 miles an hour; it was squally, and at times exceeded 50 miles an hour. The normal speed of the Antoinette monoplane on a calm day was 48 miles an hour. Immediately after the mechanics let go, the aeroplane was blown sideways, and carried away against the ground 2′ of the rear corner of the left wing. The machine was at once righted, and got head to wind once more, and now a remarkable sight was witnessed—the mechanics, who usually have to hold back the aeroplane until the signal is given to let go, had actually to push her forward in the teeth of the wind until the tractor screw was able to hold her; this gave one a good idea of the force of the wind. But still more impressive was the beginning of the flight after a run of only 25 yards. The rise from the ground was not the easy, graceful performance which one has been accustomed to see. Instead of a steady, effortless rise up a gentle incline, at a uniform speed, the aeroplane made a succession of spasmodic jumps, and almost seemed to pause for breath between each jump, as the gusts which caught the machine and cast

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it upwards also checked its forward travel for some seconds at a time. The flight, twice round the course, lasted 10 minutes 15·25 seconds. Against the wind the aeroplane was at times absolutely held up, and even for a few anxious moments driven back, showing that the force of the wind was more than 48 miles an hour; with the wind behind, a speed of 90 miles an hour was attained. Turning the corners was sometimes a troublesome performance; the aeroplane would seem for a moment to be held by the wind as in a vice, refusing to answer to her helm, and then suddenly she would whip round and face in the opposite direction, requiring to be laboriously brought back again on to the course; occasionally she had to work her way against the beam wind at an angle, to prevent being blown out of her course, and once during the second lap she was carried off about a mile and a-half out of the course by a sudden squall before she could recover herself. At the completion of the second lap the beautiful monoplane glided gracefully against the wind to the ground, and alighted without the slightest jar or shock; she was immediately seized by the mechanics, to prevent her from being blown round.

Latham maintains that the handling of an Antoinette is "simplicity itself." It requires a light hand on the wheels, so that the fingers may be sensitive to their slightest movement; the wings tend to warp themselves, and the hinged stabilizing plane in rear similarly tends to assume the necessary position to correct the flight path. These tendencies are at once detected by a sensitive touch on the control wheels, and all the pilot has to do is to assist or emphasize them.

It was just three months ago that Latham and Levavasseur, the designer of the Antoinette monoplane, were anxiously waiting on the cliffs of Sangatte for a calm day to justify the risk of the Channel flight! This serves as a useful reminder of the rapid progress which is being made in the art of flying, and let it be borne in mind that this progress is principally due to the experience in actual flight which has been gained by the leading aviators, and not to any striking improvements in the designs of their machines, though the improvements in the engines have been an essential factor. It seems clear therefore that if we are to be ready with a corps of skilled aviators to make practical use of the military aeroplane when a suitable one has been designed or adopted, we ought at once to begin to train them on any of the numerous reliable machines which are now on the market. If this were done, we should then have some practical men, who have handled an aeroplane under varying conditions, in a position to advise us in regard to design and construction when the question of adopting a machine for Army purposes has to be settled. There are hundreds of points about the construction and employment of aeroplanes for Army use which will require the most careful consideration and experiment; there is *one* which requires no consideration but much experiment, and that is the training of the *personnel* to handle them.

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NOTES ON PILE COFFER DAM FOR LONDON COUNTY HALL EXCAVATIONS.

By LIEUT. G. GUY WATERHOUSE, R.E.

THE London County Hall, of which the plans were passed some few months ago, is to be built on the south bank of the Thames, immediately adjoining the eastern side of Westminster Bridge. The front facing the river is some 800′ in length, and has before it a pathway running on an embankment somewhat similar in design to that on the opposite bank. This embankment will continue the alignment of the one in front of St. Thomas' Hospital and run flush with the bridge abutment, from the roadway of which it will be reached by a flight of steps.

The foundations of this embankment, and of much of the building itself, will be in ground which at present forms mud flats when the tide is low and which is covered by the river at high tide. To enable the necessary excavations to be made, a coffer dam has had to be provided to keep the site dry. This dam, which is at present under construction, consists of a continuous row of sheeting piles strengthened by struts which bear against "supporting piles," thus forming a watertight screen capable of resisting the pressure of the highest spring tides.

Nature of Foundations for Embankment Wall.—A rough section of the strata at the site shows a 16′ bed of Thames ballast overlying the London clay, and this, in its turn, is covered by 4′ of Thames mud.

Experience has proved that Thames ballast forms an insecure base for foundations, as its stability is greatly affected by any alteration of the quantity of water it holds. The foundations for the embankment wall are therefore being taken down to level, 23′ below the surface, *i.e.*, 3′ into the clay. To ensure against percolation of water the sheeting piles are driven to level, 32′ below the surface. The abutments of Westminster Bridge being founded on the Thames ballast, special precautions have had to be taken at this end of the wall, and these will be dealt with later. To keep out the water at spring tides a height of 18′ above mud level is required, and hence we see that the piles need to be 50′ in length (*Fig.* 1).

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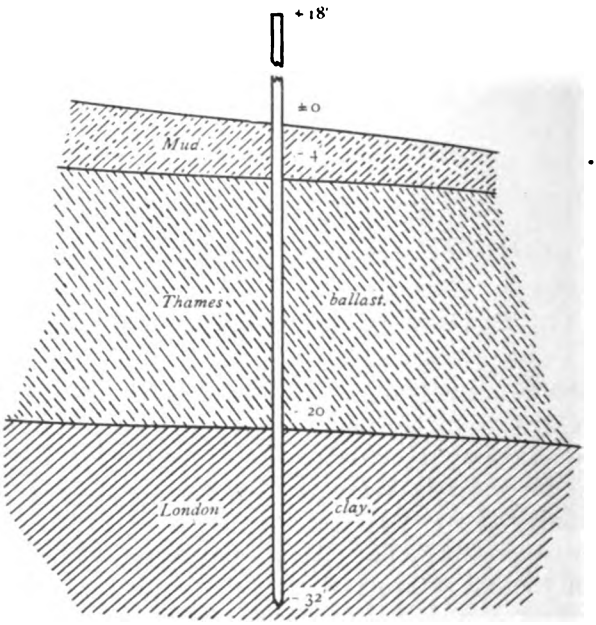

FIG. 1.

Preliminary Staging.—Before work could be begun it was necessary to construct a solid staging on which the heavy pile-driving machines could travel, and 12″ × 12″ piles were driven at high tide from pile-driving barges, so as to penetrate some 14′ into the ballast and stand 14′ above mud level. Two rows were driven 12′ apart, each row consisting of individual piles spaced at 12′, and each pair—and every alternate two bays—being diagonally braced with 12″ × 6″ stuff.

Capsills of 12″ × 12″ were run across each pair of piles, and road-bearers of similar section supported planking which carried a rail track set to gauge for the machines. All joists were secured by dogs only.

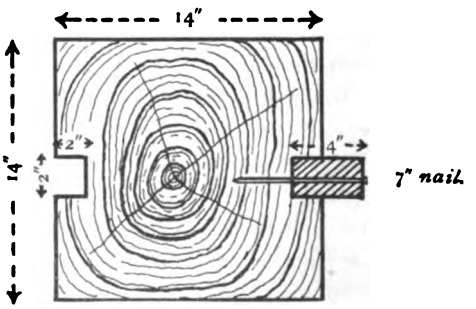

FIG. 2.—*Cross Section of Pile.*

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Piles.—The piles used for sheeting are of best Oregon pine, 14″ × 14″, and average 50′ in length. Each pile has cut in it, on opposite sides, two grooves 2″ × 2″, and into one of these a 2″ × 4″ tongue of hard wood is fastened with 7″ wire nails (*Fig.* 2).

Jarrah wood was tried for some "closer" piles (see below), but proved unsatisfactory, as, although these piles neither crushed nor broke, they frequently cracked straight through the heart, so that it was necessary to remove them.

Shoes.—"King" piles (see *Fig.* 3) were fitted with a special pointed shoe to facilitate vertical driving, others having one of a chisel shape.

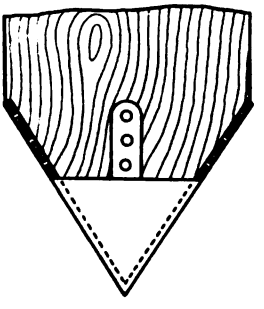
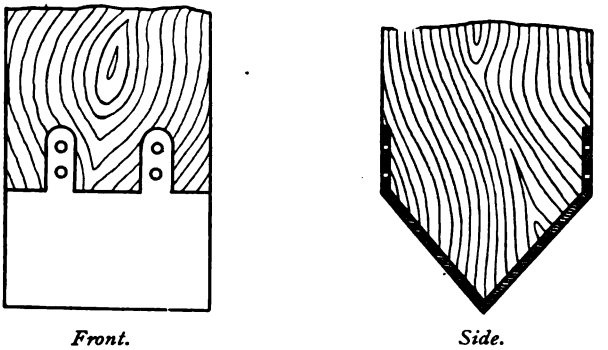


FIG. 3.—*Shoe for King Pile.*



Front. *Side.*

FIG. 4.—*Shoe for Ordinary Piles.*

Driving.—The piles for use were floated inside the staging, and picked up as required by the pile-driving machines. The first piles driven—termed "King" piles—were spaced at from 30′ to 40′. These had no tongue fitted, but had two grooves into which the tongues of adjacent piles fitted, thus ensuring that these latter were driven vertical. Piles were first driven on alternate sides of each

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"King," working outwards and afterwards inwards from the sides of the bay. Finally a gap sufficient for one pile was left, those on either side presenting grooves, and into this gap was driven a "closer" pile fitted with two tongues, and, as can be readily conceived, great difficulty was frequently met with owing to this gap being less than 14″, and narrower therefore than a pile. Great care was taken in spacing the "Kings" that this gap should never be too wide.

The London clay proved very refractory, and difficulty was encountered in driving to the requisite depth, owing to the presence of clay-stone, which is frequently quite as hard as many limestones. The principal trouble occurred with the "closers," these occasionally snapping off short, or becoming so inclined that the tongues were torn out of the grooves.

When this occurred it became necessary to draw the pile, which was effected as follows:—A piece of timber was firmly bolted to the pile to be removed, a cross-piece attached to this, and under the ends of the latter one or two hydraulic jacks resting on adjacent piles were applied. The jacks were of 30 or 40 tons. This was a laborious procedure, but was usually completed in a day. Occasionally a stump was so firmly embedded as to defy removal, and in such cases, another piece being bolted to the top, two were driven down solid as one pile.

Pile-heads were hooped with iron for driving, but this was insufficient to prevent much splitting, instances occurring when the same pile needed reheading four and even five times. "Dollies" of hard wood between the pile-head and the "monkey" have elsewhere been tried with success, but were only used here if the pile had sunk below the "monkey" guides. This constant reheading reduced the piles in height, so that when necessary they were brought up to the correct level by the addition of short pieces bolted and dogged both to the pile itself and to the adjacent ones. All joints round such packing, and all leaky spots in the sheeting were caulked with yarn soaked in red lead.

Rate of Working.—To each machine a gang of four men and a fire-boy was detailed, and the average was 10 piles in the week. The "monkey" weighed 27 cwts. and was allowed an average drop of 10′.

Strutting.—It was calculated that the mean pressure on the dam at spring tides is 1 ton per square foot, and in order to distribute this over a large area, struts bearing against "supporting" piles were made use of. These piles were 12″ × 12″, and were driven down to 28′, *i.e.*, 8′ into the London clay, 5′ to 10′ being left showing above mud level. They were spaced at 8′ intervals, and arranged in two rows 20′ apart, the nearest being 20′ from the dam. Each row was

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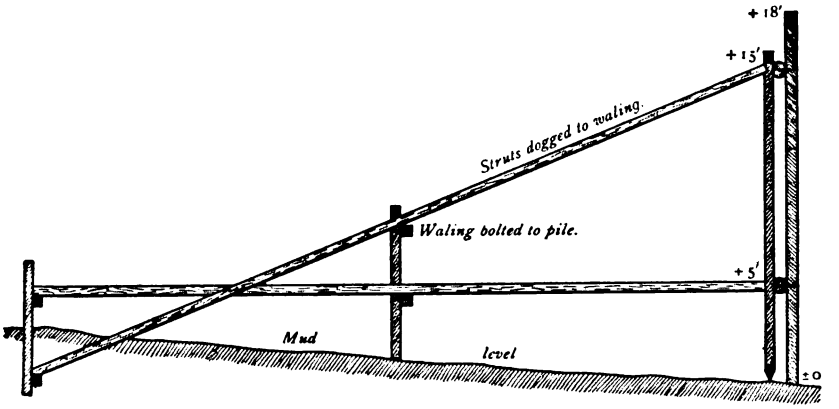

FIG. 5.

twice waled with 12″ × 12″ baulks. The sheeting piles were waled 5′ and 15′ above mud level, and from "soldier" piles placed against this waling every 8′, horizontal and inclined struts were led back to the waling along the "supporting" piles. The strutting was of 14″ × 14″ baulks, dogged to the "soldiers" and waling, the inclined strut being let in to the "soldier." This work could only be carried out when the tide was low, and was very slow, though aided by the use of cranes travelling on the staging.

Use of Caisson.—As stated above, special arrangements for carrying the weight of the embankment had to be made near the bridge abutments, as it was feared that an excavation down to the clay near by, might cause the ballast supporting the foundations to slip away. This has been avoided by sinking a caisson and building up in it a stone pier, whence iron girders will run to the abutment so as to take the weight of the wall.

Iron sheeting was first driven all round the abutment foundations to prevent movement of the ballast, and a 30′ × 20′ rectangular caisson was sunk close up to the sheeting, with its front edge in prolongation of the line of the coffer dam, which was continued up to it, and again beyond between its inner edge and the bridge. A pressure of 12 lbs. above atmosphere proved just sufficient to keep the water out. Here again the clay-stone proved an obstacle to rapid work, and had to be laboriously removed by pick and shovel. The caisson being sunk to level −28′, a concrete floor (1 of Portland cement to 6 of Thames ballast) was laid, and a pier of previously prepared stone built up to mud level. The caisson was then opened, and all removed except the riverward side, which formed part of the coffer dam.

The five girders which are to carry the upper part of the wall are 20′ long and of I-section 20″ × 7½″.

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Sluices.—To prevent strain being thrown on the dam before completion, eight $4'' \times 2''$ sluices are left. These eventually will be closed by iron plates held by screwed rods and swivel joints, the screwed part of rod passing through a nut attached to the upper part of the dam.

The work is being carried out by Messrs. Price & Reeves, under the supervision of L.C.C. engineers, and the latter very kindly gave the writer every facility for inspection, and were most ready to answer all enquiries as fully as possible.

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THE FYERS FAMILY.

(Continued).

By Col. Robt. H. Vetch, c.b., late R.E.

I now come to the grandchildren and later descendants of Thomas Fyers, Overseer of the King's Works in Scotland. These are so numerous that, in order to avoid confusion, I hope to be able to show them in a genealogical table before I finish my paper. It is only possible to make a brief reference in the text to the majority of them. Of those grandchildren and later descendants who were in the Corps, or distinguished themselves in the service of their country, I may write in more detail.

Since beginning this article fresh light has been thrown on the parentage of Thomas Fyers, Overseer of the King's Works in Scotland. Through the courtesy of Major Evan Fyers, grandson of Major-General Peter Fyers, C.B., Colonel Commandant, Royal Artillery, I have been furnished with information about his forefathers for four generations back, to A.D. 1620. It appears that these immediate ancestors of Thomas Fyers all belonged to Berwick-on-Tweed, and if the theory which I suggested at the outset of this article, that the family originally came from Stratherrick, be correct, the migration must have taken place before 1620.

Thomas Fyers, Overseer of the King's Works in Scotland, was the eldest son of William Fyers, Burgess of Berwick-on-Tweed, and was baptized in Berwick on 27th December, 1714. He himself became a Burgess in December, 1735, I presume on attaining the age of 21 years. Berwick was at that time, as it had been from Tudor days, an important fortress, and it is easy to understand how he may have learnt the art of building and may have been employed on the fortifications of Berwick, and in that way becoming known to the Military Engineers in charge, was passed on to similar work in Scotland.

Thomas Fyers, his wife Elizabeth Falconer, and their son John are all buried in St. Cuthbert's Churchyard, near the Caledonian Railway Station in Edinburgh.

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GRANDCHILDREN OF THOMAS FYERS.

The grandchildren of Thomas Fyers to be considered are :—The children of Lieut.-General William Fyers, Colonel Commandant, R.E.; of Major-General Peter Fyers, C.B., Colonel Commandant, R.A.; and of Alexandrina Fyers, wife of the Rev. James Reid.

CHILDREN OF LIEUT.-GENERAL WILLIAM FYERS, COLONEL COMMANDANT, R.E.

By his marriage with Anne Wanton, General William Fyers had ten children, two sons and eight daughters. Two of the daughters died young. Of the children who grew up, Thomas was the eldest, then followed Sarah, to whom we are indebted for the reminiscences, Charlotte, Elizabeth Lydia, Edward, Anne, who died unmarried, Louisa, and Frances. Both sons entered the Corps, and five daughters were married. The three elder daughters became mothers of large families, among whom were several well-known officers of the Services. Of the two younger, Louisa Fyers was born at Gibraltar on the 2nd November, 1794. She was married, in Dublin, to Dr. John Crampton. Frances Fyers was born at Gibraltar on the 15th October, 1797, and was married, in Dublin, in 1817 to Richard Estwick, youngest son of Samuel Estwick, of Portman Square, London, and of Barbados, West Indies, M.P. for Southampton. She died in 1882 at Twickenham, and was buried there. I shall now refer to the other children.

MAJOR-GENERAL THOMAS FYERS, R.E.

Mention has already been made in Mrs. Mann's Reminiscences of the birth of Thomas, the eldest son of Lieut.-General William Fyers, in New York on the 6th January, 1783, and of his christening, when the sponsors were Lieut.-Colonel Morse, R.E., afterwards Inspector-General of Fortifications; Lieut.-Colonel James Moncrieff, R.E., who ten years later fell mortally wounded at the Siege of Dunkirk; and Mrs. Morrison, wife of General George Morrison, Quartermaster-General to the Forces, and Equerry to H.R.H. the Duke of York. It was a matter of course that young Thomas should be a soldier. He was born and bred in a military atmosphere. The life he led at Gibraltar, where everyone was either naval or military, and where even his tutor was the garrison chaplain, confirmed his early desire to enter, if possible, his father's corps. The Reminiscences mention how in due course the little fellow was sent home from Gibraltar to the care of his bachelor uncle and namesake, Thomas Fyers, Treasurer of Malta and Deputy Paymaster in the Mediterranean, then staying in London, to be put to a school to prepare for admission to the Royal Military Academy at Woolwich. The school to which he was sent at the Blue Stile, Deptford, where his sister says that "they

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professed" to prepare boys for Woolwich, was a very second-rate place, but at that time there was no other better, and most of the youths who had obtained nominations for Woolwich went to this school to cram for the entrance examination. It was said that they learnt there little of use to them, while they acquired knowledge which they would have been better without.

After two years at school, Thomas Fyers passed the examination and was admitted to the Royal Military Academy on the 15th February, 1797, when he was just turned 14 years of age. He spent three years at the Academy, passing out for Sappers on the 19th December, 1799. But there was no vacancy for him in the Corps, so the Inspector-General of Fortifications, General Morse, who was his godfather, sent him to Gibraltar to serve under his father until such time as a vacancy might occur. The official letter, dated 15th February, 1800, said: "Thomas Fyers, late Gentleman Cadet, is to be employed as Assistant Engineer under your command at Gibraltar till a vacancy occurs in the Royal Engineers. He is to join with all despatch." He seems to have arrived at Gibraltar in January, before this letter was written, and the appointment was dated from the day he arrived. A vacancy in the Corps occurred on the 2nd May, 1800, when he was gazetted a 2nd Lieutenant, Royal Engineers. When the Gazette was promulgated at Gibraltar on the 2nd June, he was appointed Quartermaster to the Royal Military Artificers until further orders. A year later he was promoted 1st Lieutenant by augmentation. In April, 1803, he became Adjutant as well as Quartermaster to the Royal Military Artificers, and in the summer of the following year he obtained four months' leave of absence and went to England.

It is surprising that his sister's MS. makes no reference to the return of her brother to Gibraltar, for the first time as an officer of the Corps, nor of his being present at her wedding in the following year. During his four years' service at Gibraltar he must have seen all his three elder sisters married—one to a Sapper, another to a naval officer, and a third to a Gunner.

On the expiration of his leave in the autumn of 1804, Thomas Fyers was stationed at Portsmouth. While there he made the acquaintance of the Rector of Alverstoke, the Rev. F. Clifton, and his family. Mr. Clifton was a brother of Sir Gervase Clifton, Bart., of Clifton Hall, Notts, the representative of a family that traced its descent back to Alvaredus de Clifton, of the time of the Conqueror. He was promoted 2nd Captain on the 21st September, 1805, and on the 17th March, 1806, was married to Mr. Clifton's eldest daughter, Louisa, born at Alverstoke 23rd July, 1786. The wedding took place at Alverstoke Church, the rector performing the rite.

At the end of the year in which his marriage took place Capt. Thomas Fyers was moved to Chatham to take up the staff appoint-

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ment of aide-de-camp to Major-General William Twiss, Commanding Royal Engineer of the Southern District, who was responsible for the special defences then being constructed on the S.E. and S. coasts, the outcome of the threatened invasion by Bonaparte. His first child, christened William, after his grandfather, the Commanding Royal Engineer at Gibraltar, was born at Gillingham, Kent, on the 6th February, 1807. In the following year Fyers was fortunate enough to be selected for active service; and in the short space of three months he probably saw as much hard marching, sharp fighting, and as many of the difficulties as well as of the horrors of war as those who have been through numerous and longer campaigns.

In the autumn of 1808 the British Government decided to despatch an expedition to assist the Spanish armies in the north of Spain in their struggle against the French invaders. To Lieut.-General Sir John Moore, then commanding the British troops at Lisbon, the enterprise was confided. At the same time a force of 10,000 men was assembled at Falmouth, under Major-General Sir David Baird, to proceed to Coruña to join Sir John Moore at whatever place he should direct, either in Galicia or on the borders of Leon.

On the 1st October, while still serving as aide-de-camp to Major-General Twiss, Fyers received orders to join Sir David Baird's division, and he went with it to Coruña. In this present year, when the centenary of the death of Sir John Moore has been celebrated and so much has been written on the subject of his last campaign, it is unnecessary to enter into the details of the operations of the two British forces, which, starting from Lisbon and Coruña respectively, finally joined hands in Leon. It may be briefly stated that Sir David Baird was directed by Sir John Moore, so soon as the equipment, transport, and supplies of his division were organized, to advance to Astorga and be ready to join him when called upon to do so.

In addition to his duties as a Captain of the corps, Fyers was appointed an extra aide-de-camp to Sir David Baird. The Engineers in those days were usually employed in the field as staff officers, in addition to their own technical duties. They acted as intelligence and Quartermaster-General's officers in gaining information for the General about the roads and the country through which the force had to pass. They went a long way ahead of the force exploring the wild and little known country, making topographical sketches, and noting the best routes for the columns to advance by. Thus, on the 24th November, Captain J. Carmichael Smyth, Sir David's Commanding Royal Engineer, writes to his chief from Villa Franca: "The road, or pass, not far from Mauraval, leading also from Astorga to Cacavallos, is a parallel road to the royal road on which Capt. Smith (R.E.). travelled. Of this road he was not aware till he got to Villa Franca. I intend to send Capt. Fyers to examine the road to-morrow."

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The complete defeat of the Spanish armies by the French made the situation a difficult one for Sir John Moore, but he effected a junction with Baird's force at Mayorga in Leon on 20th December, and was prepared to move forward. On the 23rd, however, news arrived that Napoleon himself had set out from Madrid with a large army and was hurrying by forced marches to Benevente. Moore decided that in view of the smallness of his force, compared with the French armies, a rapid retreat to the coast was the only possible course open to him. Then began the famous retreat, first on Astorga, then on Coruña, conducted in great haste, in the winter, by forced marches over snow-covered ranges, and in the wildest weather, with a skill and courage that has made it memorable. The retreat was, nevertheless, a succession of horrors, on account of the terrible sufferings of the soldiers, and of the women and children who accompanied the army.

Fyers was present at the Battle of Coruña on the 16th January, 1809, when first his own General, Sir David Baird, was carried from the field severely wounded, and then the Commander-in-Chief mortally wounded, and it was left to Sir John Hope to complete the victory. The following day Fyers embarked with the army for England. On his arrival he found his young brother Edward under orders for Lisbon with Sir John Sherbroke's division, and before many months had passed he saw his father off in the Walcheren Expedition, to which he had been appointed Commanding Royal Engineer.

On his return from Coruña, Capt. Thomas Fyers was stationed at Portsmouth. On the 23rd April, 1810, he was promoted 1st Captain, and in the following year was sent to Guernsey; there he remained three years, and was transferred to Jersey. Altogether he spent six years in the Channel Islands. In July, 1816, he was ordered to Gibraltar. The following entries in Colonel Holloway's Journal mention his arrival:—

> "1816, August 9th, Friday.—Capt. Fyers arrived, to be in this command."
>
> "August 11th, Sunday.—Capt. and Mrs. Fyers, Lieuts. Hotham, Whinyates, and Lempriere, etc., dined with me."

Capt. Fyers spent six years at Gibraltar in his second service there, and two of his children were born on the Rock. In 1819 he received a Brevet Majority. He returned home in September, 1822.

On arrival in England, Major Fyers was unemployed for a short time, after which he joined his father's command in Ireland. In September, 1824, he was appointed Commanding Royal Engineer in Jersey, was promoted Lieut.-Colonel six months later, and remained at Jersey until the end of 1830, thus completing a second six years' service in the Channel Islands. He had now 30 years' service. His family consisted of nine children, the youngest, Amelius Beauclerk,

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afterwards a Colonel in the Corps, having been born at Jersey the year before he left.

His next service was as Commanding Royal Engineer in Mauritius. At that time the island was both healthy and prosperous. The abolition of slavery, though in the air, had not yet taken place, a great deal of money was made in the island, and the planters lived in great luxury and were very hospitable. So Mauritius was a coveted foreign station for officers, who also enjoyed there a generous colonial allowance in addition to their meagre pay. Fyers took his wife and most of his children with him to Mauritius, and the name of Fyers became as well known in the island as it had been in his father's time at the Rock. There he remained for over 14 years; all his daughters were married there; one of his sons married and settled in the island; while another son, in the Royal Artillery, was posted to the battery in Mauritius in 1834, and remained in the same garrison with his father for eight years.

Thomas Fyers became a Regimental Colonel in 1837, but he did not return to England until 1845. He was promoted to be Major-General, and retired in November, 1846. He died at Woolwich on the 11th May in the following year. His widow returned to Mauritius and lived on there to a great age, dying on the 6th October, 1881, aged 95 years.

By his marriage with Louisa Clifton, Thomas Fyers had eleven children, six sons and five daughters, viz. (omitting a son and a daughter, who died young):—

I. WILLIAM FYERS, born at Gillingham, Kent, on the 6th February, 1807. He was commissioned as Ensign in the 11th Foot, North Devonshire Regiment, in 1825. He married at Corfu, on the 31st July, 1832, a Greek lady, Catherine Economede. He died at Santa Maura on the 29th December, 1852, leaving issue:—

(1), Thomas Fyers, who died in 1867; (2), Robert Fyers, formerly in the War Office; and (3), a daughter (Louisa).

II. FRANCIS CLIFTON FYERS, born at Alverstoke, Hants, on the 18th February, 1810. He was commissioned in the 47th Foot, and exchanged into the 4th Light Dragoons. He died at Bomina Kolta, in India, on the 14th December, 1838. He was unmarried.

III. Louisa Fyers, born in Guernsey on the 13th July, 1811; married at Mauritius, on the 24th January, 1834, the Rev. Langrishe Banks. She died in Dublin in 1893. The issue of this marriage was:—

(1). The Rev. William Thomas Banks, born in 1835, who died unmarried in 1868.

(2). LANGRISHE FYERS BANKS, born at Mauritius on the 26th September, 1836, who was for many years Secretary of the Royal Hospital, Kilmainham, Dublin. He married his cousin, Anne Sabine Wainwright, at Bath in 1863, and has issue.

IV. Rose Matilda, born at Guernsey on 30th December, 1812; was

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married at Mauritius on the 24th January, 1834, on the same day as her sister Louisa's wedding, to CAPT. CHARLES CORNWALLIS BROWNRIGG, of the 9th Foot. He was born in 1800, and died in 1872 without issue. Mrs. Brownrigg lived to a great age, dying in Mauritius in 1907, aged 94 years.

V. ROBERT MORSE FYERS, born in Jersey on the 9th September, 1815, was commissioned in the Royal Artillery on the 21st June, 1833, as a Second Lieutenant, and posted to the battery in Mauritius in the following year. He was promoted to be 1st Lieutenant in 1836, and continued to serve in Mauritius until 1842. On the 31st August, 1841, he married, at Mauritius, Sophia Charlotte, daughter of the Rev. Mark de Joux. In 1845 he retired upon half-pay, and died at Northampton on the 16th February, 1849. His wife survived him. There was no issue of the marriage.

VI. Thomas Edward Fyers, born at Gibraltar on the 15th January, 1820; settled in Mauritius as a planter. He was twice married. First, at Mauritius, on 31st August, 1842, to Isabella Eliza, second daughter of the Rev. Mark de Joux, and sister of Mrs. Robert Morse Fyers. She died in 1870. Secondly, on the 27th December, 1875, to Selina, widow of R. G. Cummins, and daughter of B. N. Kyshe. She is still living in Mauritius. Thomas Edward Fyers died in 1887, leaving issue by his first wife :—(1). Ada Isabel Fyers, who married George Perromat, and is living at Mauritius with three children, a son and two daughters.

By his second wife Thomas Edward Fyers had three children, two sons and a daughter. One of the sons died young.

(2). The other, Thomas Edward Fyers, born in 1879, is in the Soudan Government Railways.

(3). The daughter, Alice Louisa, born in 1878, married, in 1900, FRANCIS D. THOMSETT, Engineer Commander, R.N., son of Lieut. H. G. Thomsett, R.N., C.M.G., Member of Council at Hong Kong.

VII. Renée Theresa, born at Gibraltar on the 26th January, 1822; married at Mauritius, on the 12th February, 1840, Lieut. HENRY AUSTIN TURNER, Royal Artillery, afterwards Major-General. He was the second son of the Rev. Joseph Turner, D.D. and J.P., Vicar of Duleek and Rector of Raddenstown, co. Meath, and grandson of Timothy Turner, of Dublin, who died in 1785. General Turner died at Bath in 1875, aged 60 years. His widow died at the same city in 1886. There were twelve children of the marriage, but many of them died young, and three were carried off in a few weeks by yellow fever in the epidemic at Barbados of 1852. The survivors were :—

(1). HENRY FYERS TURNER, born at Mauritius on the 8th November, 1840; was commissioned in the Royal Engineers on the 23rd December, 1857, in the writer's batch. As a Colonel he was Commanding Royal Engineer of the North-Eastern District at

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York, and later (1894—1897) was Deputy Inspector-General of Fortifications, a post occupied by his great-grandfather, Lieut.-General William Fyers, nearly a century before. He was created a C.B. in 1896. He married, in 1864, Harriet, eldest daughter of the Hon. J. G. Spragge, Vice-Chancellor of Ontario, Canada, and afterwards Chief Justice. She died at Inverness in 1872. Colonel H. Fyers Turner died at Bath on the 17th September, 1909. He had issue :—

(*a*). H. Katherine Theresa Turner; married to Lieut.-Colonel A. C. PAINTER, Royal Engineers. (*b*). HENRY HAMILTON FYERS TURNER, Major, 2nd Lancers (Gardner's Horse), D.A.Q.M.G., Headquarters, India. He married Effie, daughter of Colonel Campbell Ross, of the Bengal Staff Corps, and has issue, a son, Reginald Hamilton Fyers Turner, born in 1897. (*c*). Eleanor Ada Turner, died in 1889.

(2). Eliza Georgina Louisa Josephine Turner, born at Fort George, Grenada, West Indies, on 16th July, 1849; died unmarried at Bath in 1908.

(3). ALFRED HEYLAND PARRATT TURNER, born at St. George's Bermuda, is a Colonel in the Royal Artillery. He married May, daughter of Major-General EUSTACE HILL, Madras Staff Corps, and has a family of four children :—(*a*). Eustine Turner, married to Lieut. C. GOULDEN, R.N. (*b*). HORACE TURNER, Lieut., Indian Army. (*c*). REGINALD AUBREY TURNER, 2nd Lieutenant, Royal Engineers. (*d*). TIMOTHY FYERS TURNER, Cadet, R.N.

(4). Emmeline Flora Theresa Turner; married, first, G. Trask, and, secondly, B. Creasy.

(5). ARCHER LHOYD MARISCHAL TURNER, born at St. George's, Bermuda, in 1860 (twin with preceding), is a Colonel, Royal Artillery. He married Mary, daughter of Lieut.-Colonel E. P. ST. AUBYN, of the 10th Madras Native Infantry. She died in 1907. He has a son—(*a*). Archibald Turner, born in 1898.

VIII. Charlotte Sabine Fyers, born at Jersey on the 11th of November, 1824; married at Mauritius, on the 2nd of February, 1842, GEORGE DRAKE WAINWRIGHT, of the Hon. East India Company's Service, son of the Rev. John Drake Wainwright, Rector of Sturmer, Essex. He died at Bath in 1859, aged 47 years, and his widow died in the same city in 1892. There were six children of the marriage, viz. :—

(1). Anne Sabine Wainwright; married at Bath, in 1863, LANGRISHE FYERS BANKS, Secretary, Royal Hospital, Kilmainham, Dublin, and had issue. She died on the 6th July, 1882.

(2). CHARLES B. FYERS WAINWRIGHT was commissioned in the Royal Artillery as Lieutenant in January, 1867. He died at Sitapur, India, unmarried on 29th May, 1869.

(3). Alice Louisa Wainwright; married Arthur Wilson, of Sandridge

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Park, Devon, and has issue, a daughter, Gladys Sabine Fyers Wilson.

(4). Theresa Wainwright; married the Rev. G. Irvine, Vicar of Bulford, Wilts, son of Canon Irvine, of Belfast, and has issue.

(5). George Francis Drake Wainwright, born in 1856, died unmarried at Bath in 1887.

(6). Edward Wainwright, born in London in 1858, is in the Agricultural and Mines Department, Sydney, N.S.W. He married a daughter of Capt. Fanning.

IX. AMELIUS BEAUCLERK FYERS, born at Jersey on 12th July, 1829, Colonel, Royal Engineers, Surveyor-General of Ceylon and Member of the Legislative Council, will be noticed separately. He married, first, at Mauritius, in 1850, Anne Eliza, daughter of Capt. WILLIAM BROWNRIGG. She died at Colombo, Ceylon, in 1869. Second, Adelaide Isabella, youngest daughter of Colonel Forbes Leith, of Whitehaugh, Aberdeenshire, at Colombo, in December, 1872. She died at Aberdeen in November, 1874. Colonel Amelius B. Fyers died at Bath on the 5th April, 1883, having had issue by his first marriage :—

(1). Mary Anne Louisa Fyers, born in 1851 ; married —. Ffinch, of the Ceylon Civil Service, and has issue.

(2). William Amelius Beauclerk Fyers, born in October, 1852, was in the Ceylon Civil Service. He died at Trincomalee in July, 1886. He married, first, Eliza Bogue, by whom he had two daughters and a son, Harry Amelius Beauclerk. Secondly, Cissy Neville, by whom he had Amelius Beauclerk.

(3). Charles Cornwallis Meadows Fyers, born at Mauritius in February, 1854. He was in the Ceylon Civil Service. He married Annie Mitchell, by whom he had three sons and a daughter.

(4). Renée Sabine Fyers, born at Mauritius in July, 1855. She married H. C. P. Bell, Ceylon Civil Service, and had issue, three sons and three daughters.

(5). Laura Isabella Fyers, born at Mauritius in September, 1857. She married C. M. Lushington, Ceylon Civil Service, and had issue, four sons and three daughters.

(6). Henry Francis Clifton Fyers, born at the Curragh, Ireland, in March, 1859. He was in the Ceylon Forest Department. He married, in London, Alice Mary, daughter of James King, of Belsize Park Gardens, and late of the Cape.

(7). Frances Henrietta Fyers, born at the Curragh Camp, Ireland, in October, 1860. She married P. G. PARKINSON, who was, it is stated, an officer in the Army, but I have not as yet been able to trace him. He had issue, three daughters and a son. She died in October, 1890.

(8). Robert Montague Fyers died young.

(9). Adelaide Hay Fyers, born at Malta in February, 1865. She married C. Hodgson, with issue, two sons and two daughters.

(10). Kate Minnie Fyers, born at Colombo, Ceylon, in August,

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1867. She married F. Simpson, Ceylon Civil Service, and has issue, two daughters and a son.

By his second wife Colonel Amelius Beauclerk Fyers had—

(11). Amelia Adelaide Wilhelmina Helen, born in Aberdeen in November, 1874.

MAJOR EDWARD FYERS, R.E.

Edward Fyers, the younger son of Lieut.-General William Fyers, was born at Gibraltar on the 8th January, 1791. It may be remembered that his sister Sarah (Mrs. Cornelius Mann) mentions the grand doings that took place at his christening, when H.R.H. the Duke of Kent was his godfather. It may be presumed that the boy followed in due course in the footsteps of his brother Thomas, was sent home at an early age to be put to school, and was prepared for the entrance examination for Woolwich at the Blue Stile at Deptford. It was then usual for those lads who succeeded in passing the examination to go for the first year of their cadetship to the College at Great Marlow, and then join at the Royal Military Academy at Woolwich. Fyers obtained a commission as 2nd Lieutenant in the Royal Engineers on the 22nd April, 1808, and was stationed at Dover.

He was then a little over 17 years of age, and was soon to see active service. In January of the following year his brother Thomas arrived home with the army from Coruña. At this time the British force at Lisbon had been reduced to 8,000 men, under Lieut.-General Sir John Cradock. On the advance of the French into Portugal, Cradock concentrated his small force at Passo d'Arcos, at the mouth of the Tagus, so that in case of necessity he might be in a position to embark his troops. But the British Government had no intention of abandoning the whole continent to Bonaparte, and determined to take vigorous action in the Peninsula. It was decided at once to strengthen Cradock's force. A division, under Major-General Sir John Coape Sherbroke, was despatched to Lisbon, and Edward Fyers accompanied it.

On Sherbroke's arrival at Lisbon he received orders to go on to Cadiz, and offer to land his men and assist the Supreme Junta of Seville in resisting the invader. The Spaniards were too proud to accept the assistance offered, and Sherbroke returned with his division to Lisbon and joined Cradock's command.

Strengthened by this reinforcement, Cradock was able to take up a position at Saccovino, covering Lisbon, and thus give confidence to the Portuguese, who had been in a state of panic. Their apprehensions had been raised by the withdrawal of the British Army from Spain after Coruña, and the subsequent invasion of their country by the French, under Marshal Soult.

By the time Sir Arthur Wellesley arrived in Lisbon to take supreme command of the allied armies, on the 22nd April, 1809, Marshal Soult,

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having captured Oporto, was preparing for an advance through Coimbra on Lisbon. Wellesley decided to make a rapid march on Oporto and drive Soult out of it. Edward Fyers was with the army in this campaign. He took part in the passage of the Douro, the capture of Oporto, and the pursuit of Soult, until the French Army had been driven ont of Portugal and across the frontier into Spain, with the loss of all its impedimenta, and utterly demoralized.

On the return of the British Army to Lisbon after this brilliant exploit, Wellesley concentrated his forces on the Tagus and arranged with the Spanish General, de Cuesta, to advance on Madrid. He accordingly moved to Placentia in June, where the armies were prepared for further advance. Fyers was with the army in the advance, and was present at the Battle of Talavera on the 27th and 28th July. But when the desertion of General Cuesta and the Spanish Army compelled Wellesley to retire after that battle, and the army was on the line of march, Fyers was seized with a serious illness and sent to Lisbon. This attack culminated in brain fever, and he was sent home in October, 1809. Unfortunately the results of the illness affected him in after life, and from time to time he had a tendency to fits of mental aberration.

He returned to duty at Dover in December, 1809, but he only remained there a short time. In March, 1810, he was moved to Landguard Fort, near Harwich, in the Eastern Military District, and in the following year was appointed aide-de-camp to his father, at that time the Commanding Royal Engineer in Ireland.

Two years later he was sent to Plymouth. On 21st July, 1813, he was promoted 2nd Captain, but the year after he was again attacked by his malady, and had to go on sick leave for a lengthened period. He resided in Edinburgh during part of this time, and he seems so far to have recovered that in 1818 he was attending lectures at the Edinburgh University, and his father began to hope that he was permanently cured.

This was not the case, and a severe relapse in 1819 decided General Fyers to apply for his son's transfer to the Invalid Corps. In consideration of Edward Fyers' services in the Peninsula, the Duke of Wellington approved of the transfer on the 15th December, 1819.

On the abolition of the Invalid Corps in December, 1831, Edward Fyers was placed on the Retired Full Pay List. He was then living in Inverness-shire, and appears to have been in good health, for he applied for a Medical Board with a view to his rejoining the effective strength of the Corps, but he was told there was no vacancy. Five years later he contributed a paper to the *United Service Magazine*. He received a brevet majority on 28th November, 1854, in recognition of his Peninsula service, and on the 12th of the following month he died, unmarried, at Inverness.

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SARAH FYERS, WIFE OF MAJOR-GENERAL CORNELIUS MANN, R.E.

Sarah Fyers, second daughter of Lieut.-General William Fyers—his eldest daughter had died young—was born in London on the 2nd December, 1784. She has told her own story, up to the time of her marriage, in her Reminiscences. She married Lieut. Cornelius Mann, R.E., at Gibraltar, on the 15th July, 1801.

Cornelius was the second son of General Gother Mann (1747—1830), who was Inspector-General of Fortifications and a Colonel Commandant of the Corps. He had declined a baronetcy offered to him for his services.*

The elder brother of Cornelius, Gother Kerr Mann, was in the Royal Artillery, and died on passage from the West Indies in 1804. Other brothers were :—John, in the infantry, and Frederick William, in the Royal Staff Corps. The last named was the father of Major-General Gother Mann, C.B., R.E., who died in 1881, and whose daughter married Major D. C. Courtney, R.E. A sister of Cornelius was Miss Ann Mann, well known to some of the older officers of the Corps now living, as the housekeeper at the Royal Military Academy at Woolwich. The Manns, like the Fyers, were a very military family, and they have been well represented in the Corps and in the Services. In the index of the *Army List* for 1812 there are no less than nine Manns given. Through the marriage of Sarah Fyers with Cornelius Mann, several representatives of the Mann family in the Corps are descendants of Thomas Fyers, Overseer of the King's Works in Scotland.

Cornelius Mann was born in Antigua, in the West Indies, in November, 1779. He was commissioned in the Royal Artillery as 2nd Lieutenant in April, 1795, and was transferred to the Royal Engineers in February, 1796. He was favourably reported upon by Major-General F. G. Mulcaster, towards the close of that year, as "a very deserving young man." He went to Gibraltar in May, 1799, and in December, 1802, the year after his marriage, was promoted to be Captain-Lieutenant. In July, 1803, he was ordered home, his brother-in-law, Thomas Fyers, taking over the command of his company at Gibraltar. While at Gibraltar his eldest child, Charlotte Anne, was born. On returning home he was stationed at Fort George, near Inverness, where two more daughters were born. On the 10th July, 1804, he was promoted 2nd Captain, and at the end of 1805 he was sent to Athlone. He was promoted 1st Captain in July, 1806, while at Athlone, where his eldest son, Gother Kerr, was born.

On leaving Ireland in 1811, Capt. Cornelius Mann was appointed aide-de-camp to his father, General Gother Mann, then Inspector-General of Fortifications. This post he held till the end of 1814. He

* See *Dictionary of National Biography.*

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had been promoted Brevet Major in June, 1813, and Regimental Lieut.-Colonel in September, 1814. When he came to London he took a house at Lewisham, in Kent, which was a convenient neighbourhood, as his duties lay at the Tower of London. His father continued to be Inspector-General of Fortifications until his death in 1828, and although Cornelius was obliged to cease being his aide-de-camp on his promotion to a regimental lieut.-colonelcy, he continued to be a member of his staff, as he was appointed Assistant Inspector-General of Fortifications and a member of the Tower Committee. He continued to hold these appointments for no less than 16 years. He became a full Colonel in 1825, and as he remained at the Tower for two years after his father's death, it can only be presumed that his services there were deemed indispensable. Thus for 19 years his office had been at the Tower of London and his house at Lewisham, where seven out of his 11 children were born.

In September, 1830, he was sent to Gibraltar as Commanding Royal Engineer, and for seven years Mrs. Mann again occupied—this time as its mistress—the home of her childhood. She was able to recall her own young days, when she and her sisters were married in their teens from the Commanding Royal Engineer's quarter, and to reproduce the situation by marrying two of her own daughters from that house.

Cornelius Mann became a Major-General on the 10th January, 1837, but continued as Commanding Royal Engineer at Gibraltar until the following September. On returning home he was placed on the Unemployed List. He resided at Shooter's Hill with his wife and unmarried daughters. His youngest son, James Robert Mann, was then about to join the Royal Military Academy at Woolwich as a cadet.

Major-General Cornelius Mann died at Shooter's Hill, Woolwich, three years later, and was buried in Plumstead Churchyard, where there is a stone tablet to his memory, bearing the following inscription :—

In this vault rest the remains of
CORNELIUS MANN,
Colonel in the Corps of Royal Engineers.
Died 5th October, 1840.
Aged 61 years.

His wife survived him six years, dying at Binstead, Isle of Wight, on the 6th September, 1846.

There were eleven children of the marriage—six sons and five daughters, viz. :—

I. Charlotte Anne Mann, born at Gibraltar on the 25th June, 1802. She died unmarried.

II. Eliza Mary Mann, born at Fort George, Inverness, on the 23rd

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of February, 1804. She married, in 1835, CHARLES DEMPSEY, Army Surgeon.

III. Sarah Mary Mann, born at Fort George, Inverness, on 24th July, 1805. She died unmarried.

IV. GOTHER KERR MANN, born at Athlone, Ireland, on 20th February, 1809. He was a Captain in the Bombay Horse Artillery, from which he retired to settle in New South Wales. He married Mary Hely, and had issue :—

(1). Gother Frederick Mann; married Lucy Campbell, and had issue :—

(*a*). Gother F. Campbell Mann, who married Grace Doyle, and has a daughter, Claire Loyalty Mann. (*b*). Arthur P. A. Campbell Mann. (*c*). Jeffry Campbell Mann. (*d*). Georgina Blanche Campbell Mann, who married Arthur Lungley, and has a daughter, Lucy Joan. (*e*). Elsie Mary Campbell Mann, who married ALEXANDER MACLEAN, Staff Surgeon, R.N. (*f*). Millicent Fanny Campbell Mann; married Robert Logan Ranken, with issue, three sons and two daughters. (*g*). Margaret Campbell Mann; married Francis James Irwin, with issue, one son. (*h*). Dorothy Lorn Campbell Mann; married Lieut. CYRIL CALLAGHAN, R.N. Issue, a daughter.

(2). Leslie Gordon Mann.

(3). Reginald Fyers Mann; married Alice Stewart. Issue, two daughters.

(4). Herbert William Mann; married Mary Brady. Issue, a son and four daughters.

(5). John Cornelius de Saumarez Mann.

(6). Georgina Alice Mann; married Mordaunt William Shipley Clarke, M.A., and has issue :—

(*a*). William Brauthwaite Clarke; married Elinor Harriott, and has issue, two daughters. (*b*). Gother R. Carlisle Clarke, M.B. (*c*). Mordaunt Lindsay Clarke. (*d*). Blanche Mabel Alice Clarke; married the Rev. David Davies, M.A., and has issue, a daughter and a son. (*e*). Nellie Moreton Clarke. (*f*). Nora Katherine died.

(7). Captain Gother Kerr Mann had six other daughters, all unmarried.

V. Alicia Anne Mann, born at Lewisham, Kent, on 21st March, 1811; married on 5th November, 1835, at Gibraltar, Captain GEORGE EDWARD THOROLD, 92nd Highlanders, and had issue :—

(1). REGINALD GOTHER THOROLD, Major-General, R.E. He married Charlotte Elton, daughter of Lieut. J. F. Elton and his wife Charlotte Young, and granddaughter of Vice-Admiral James Young. He had issue, a son and a daughter.

(2). Edith Rhoda Thorold, who married the Rev. E. Cole, and has issue :—

Two sons. (*a*). Rancely Cole, in the Church, and AUBREY DU P. T. COLE, Captain in the 6th Dragoon Guards.

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VI. Harriet Louisa Mann, born at Lewisham, Kent, on 25th February, 1813; unmarried.

VII. CORNELIUS MANN, born at Lewisham, Kent, on 18th October, 1815. He successfully passed the final examination at the Royal Military Academy at Woolwich, and was recommended for a commission in the Corps, but died before he was gazetted.

VIII. William Mann, F.R.A.S., born at Lewisham, Kent, on the 25th October, 1817, was, in 1837, appointed Second Assistant Astronomer at the Royal Observatory, Cape of Good Hope, and, 10 years later, First Assistant. He married, in 1853, Caroline, daughter of Sir Thomas Maclear, Astronomer at the Cape. He died in South Africa, leaving a family of six children, three sons and three daughters. Two of the sons and two of the daughters are married.

IX. John Frederick Mann, born at Lewisham, Kent, on the 15th December, 1819, settled in New South Wales. He married Camilla Mitchell, and has had issue :—

(1). Livingstone Mann; married Harriet Shaw, issue, a son and daughter. (2). Gother Victor Fyers Mann; married Mabel Newman, and has a daughter. (3). Mary Emily Blount Alicia Mann; married F. Bell, and has two sons.

X. EDWARD PETER MANN, born at Lewisham, Kent, on the 2nd January, 1822, joined the 92nd Highlanders in 1846. He married Isabella Wright, and had issue :—

(1). Horace Mann; married Madeline Lee, and has issue, a daughter.

(2). Allan Mann; married Nina Brown, and has issue, two sons and four daughters.

(3). Edward Mann.

(4). Alice Georgina Mann; married LEONARD PARTRIDGE, R.N., and had issue, a son (*d.s.p.*) and two daughters.

(5). Edith Mann; married F. WHITEHOUSE, R.N., and has a son, EDWARD WHITEHOUSE, R.N.

(6). Florence Mann; married Captain LUCAS, R.N., and has a son, CHARLES LUCAS, R.N.

(7). Amy Adeline Mann.

XI. JAMES ROBERT MANN, born at Lewisham on the 9th March, 1823, is a Major-General and C.M.G., late of the Royal Engineers. He married, in 1848, Caroline Boyd Geddes, and has had issue :—

(1). GOTHER FYERS MANN, born at Montreal, Canada, in 1849; Lieut.-Colonel, Royal Engineers.

(2). ALLAN CORNELIUS THOROLD MANN, born at Milford, Hants, in 1851, was a midshipman, R.N., and went down in H.M.S. *Captain* in 1870.

(3). Harry P. W. Mann, died young.

(4). Georgina Louisa Mann, born at Mauritius, in 1856; married COLONEL PARKYN, R.A., and has two sons.

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(5). James R. G. Mann, died young.

(6). ARTHUR FREDERICK MANN, born at Mauritius in 1859, was in the Royal Munster Fusiliers, and retired as a Major.

CHARLOTTE ANNE FYERS, WIFE OF VICE-ADMIRAL JAMES YOUNG, R.N.

Charlotte Anne Fyers, second daughter of Lieut.-General William Fyers, was born at Gosport on the 8th July, 1786. She went with the family to Gibraltar in the following year, and remained there until after her marriage in 1802. She was a remarkably pretty girl, and was known as the "Beauty of the Rock." She was not much over 16 years of age when she married, at Gibraltar, Capt. James Young, R.N., of Barton End House, near Nailsworth, Gloucestershire, a younger brother of Admiral Sir William Young. Born in 1766, he distinguished himself when, in command of the frigate *Ethalion* (38), in October, 1799, he chased the Spanish frigate *Thetis*, laden with treasure from Mexico, worth £600,000, brought her to action, and, after an hour's running fight, succeeded in capturing her. His own share of the prize money exceeded £40,000. He became a Vice-Admiral of the White, and died on the 8th March, 1833. His widow died at Stanley Hall, Gloucestershire, the seat of her son-in-law, the Rev. S. Lloyd, on the 18th September, 1850, and was buried at Horsley, Surrey.

There were twelve children of the marriage, viz. :—

I. JAMES YOUNG, born 15th March, 1803, was Lieut.-Colonel of the 65th Regiment. He married, in 1846, Ann E. Longworth, and died 16th June, 1882.

II. WILLIAM FRANCIS YOUNG, born on 1st June, 1804, was a Commander, R.N. He married on the 4th June, 1834, the eldest daughter of Josiah Gaston Guest, of Warmington Grange, Gloucestershire. He died on 4th August, 1881.

III. HENRY YOUNG, born on 21st July, 1805, was commissioned in the 24th Foot in 1825, and retired as Lieut.-Colonel of the regiment in 1858. He married, on 8th July, 1831, Rosina Frances, third daughter of Henry Martin, of Sidmouth. She died at Ventnor in 1862, and Colonel Henry Young died at Trematon Castle, Cornwall, the residence of his eldest sister, Mrs. Jervis Tucker, in 1866. He had a family of eight children—five sons and three daughters, viz. :—

(1). Henry Chapman Young, born in 1832 ; died, unmarried, in 1855.

(2). Edward William Young, born in 1833 ; married Geraldine Lloyd.

(3). Rosina Harriet Young, born in 1839 ; married in 1865, at Madras, John Herbert Latham, and had issue, two sons and two daughters.

(4). Augustus Murray Young, born 1841, was in the Church. He died, unmarried, in 1871.

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(5). Sophia Young, born in 1842.

(6). Alice Stavely Young, born in 1844; married, in 1867, George Gordon, Esq., and had issue:—(*a*), A daughter, Alice Elizabeth Gordon, who married E. B. Gould, and (*b*), a son, Douglas Gordon, *d.s.p.* Mrs. Gordon died in 1871.

(7). Francis Walter Young; born in 1845; died in 1868.

(8). JAMES BROWNING YOUNG, born in 1847, was a Captain, R.N. He married, in 1879, Margaret, second daughter of the Rev. C. Gambier, and had issue:—(*a*). MAURICE J. D. YOUNG, born in 1880; in the Indian Army. (*b*). Cicely Margaret Young. (*c*). MARTIN YOUNG, born in 1884; in the York and Lancaster Regiment.

IV. Sabine Anne Young, born 27th July, 1806; married at Horsley, Surrey, on the 16th October, 1830, Capt. JOHN JERVIS TUCKER, R.N., afterwards Admiral, D.L., and J.P., of Trematon Castle, Saltash, Cornwall. They had eight children, of whom seven were daughters. The only son and second child was JERVIS TUCKER, born in 1883; he was commissioned in the Royal Artillery in 1854, saw service in the Crimean War, went on half-pay in 1860, and has since retired from the Service. The Admiral died in 1886.

V. EDWARD YOUNG, born in 1808; was a Lieutenant, R.N. He married a Miss Baker, and died in 1842.

VI. CHARLOTTE YOUNG, born on 30th December, 1809; married, first, at Horsley, Surrey, on the 9th July, 1835, Lieut. JAMES F. ELTON, of the 40th Foot. He died about 1844. Second, her cousin, James Kerr, Barrister. By her first husband she had four children:—

(1). FREDERICK ELTON, born in 1836, was commissioned in the Royal Artillery in November, 1854. He served in the Crimea, receiving the medal and clasp, Knight of the Legion of Honour, and Turkish medal; also in the Egyptian Campaign of 1882, for which he was mentioned in despatches, created a C.B., and received the medal with clasp, the 3rd Class of the Medjidieh, and the Khedive's Star. He retired as a Colonel.

(2). Charlotte Elton.

(3). Ada Elton, who married the Rev. —. Hales.

(4). Julia Elton.

VII. Sophia Young, born on 14th February, 1811; married at Horsley, Surrey, on the 14th January, 1837, Lieut. BARTHOLOMEW JAMES SULLIVAN, R.N., afterwards Admiral Sir B. James Sullivan, K.C.B., who died in 1890. She had four children—two daughters and two sons, viz.:—

(1). Frances Emma Sullivan.

(2). Catherine Sabine Sullivan, who married Wallace French.

(3). JAMES YOUNG FALKLAND SULLIVAN, R.N.

(4). Thomas Edward Sullivan.

VIII. Eliza Young, born in 1812, fourth daughter of the Admiral; married the Rev. S. Lloyd, of Stanley Hall, Gloucestershire. He died

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in 1863, and his widow some years later (1874 ?). They had four children :—

(1). A son, W. H. Lloyd.

(2). Clara Lloyd, born in 1835.

(3). E. Rose Lloyd, born in 1837.

(4). E. Frances Lloyd.

IX. Louisa Young, born in 1813; married on the 30th August, 1835, the Rev. Joseph Henry Jarrard, D.C.L.

X. Elizabeth Young, born in 1815; died in 1850, at Clevedon, Somerset, from the effects of a fall from her horse. She was a very handsome woman, but unmarried.

XI. Harriet Young, born in 1817; married in 1841, at Horsley, the Rev. George J. Comyns, of Bishopsteignton, Devon. He was Vicar of Exmouth, and later of Ledbury.

XII. Frances Young, born in 1820; married, on 6th May, 1840, the Rev. William R. Sweetland, of Newton Abbott, Devon.

ELIZABETH LYDIA FYERS, WIFE OF GENERAL THE HON. WILLIAM HENRY GARDNER, COLONEL COMMANDANT, R.A.

Elizabeth Lydia, third daughter of Lieut.-General William Fyers, was born at Gosport on the 24th February, 1788, while her father was stationed there. She was the baby of the family when soon after her birth they moved to Gibraltar, and she never left the Rock until after her marriage.

Her eldest sister, Sarah, had been married at Gibraltar to Lieut. Cornelius Mann, R.E., on 15th July, 1801, some months before she was 17 years of age. Her sister Charlotte had been married at Gibraltar to Capt. James Young, R.N., in 1802, at a little earlier age, but Lydia outdid them both, and was married at Gibraltar on the 20th February, 1804, when she was not quite 16 years old. Her husband was the Hon. William Henry Gardner, third son of the first Baron Gardner, the famous Admiral, who was rewarded with a peerage for his distinguished services. Born in 1774, he was then a Captain-Lieutenant in the Royal Artillery, in which his first commission was dated September, 1793, and in September of the year of his marriage he was promoted Captain. I have not got a record of his services, but I am informed that he served a good deal in the Horse Artillery, and his war service was limited to the Expedition to Walcheren, in which both his wife's father and uncle served, the latter being his own contemporary in the Regiment.

In the reign of William IV. Colonel Gardner held office in the household of Queen Adelaide. He was promoted to be Major-General in January, 1837, became a Colonel Commandant of the regiment in April, 1846, was promoted Lieut.-General in November of that year, and General in June, 1854.

His wife died in 1849. He survived her some years, dying on the

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15th December, 1856, at Bishopsteignton, Devon, where his epitaph may be seen.

They had a family of 10 children, five sons and five daughters, as follows :—

I. Anne Europa Gardner, born in 1804, at Europa Point, Gibraltar, during the plague ; married, in 1829, Capt. (afterwards Vice-Admiral) THOMAS LEWIS GOOCH, R.N., born in 1807, third son of the fifth baronet of Benacre Hall, Wangford, Suffolk. The Admiral died in 1876, but his wife died much earlier (in 1839), leaving an only child:—

(1). THOMAS SHERLOCK GOOCH, of Tickhill, York, born in 1831, was a Captain in the Royal Navy. He married, in 1861, Catherine Lydia Mackenzie James, born in 1842, daughter of Capt. JOHN JAMES, 85th Foot, and sister of the late Major-General E. R. JAMES, R.E. Capt. Gooch died in 1897, with issue :—(*a*). Anne Georgiana Sherlock Gooch. She married, in 1886, her cousin, Philip Edward Scholfield (died in 1896), of Maltby Hall, Yorkshire, only son of the Rev. P. Scholfield (died in 1881), Vicar of Goulceby, Lincolnshire, by Georgiana Anne (died in 1878), youngest daughter of Sir Thomas Sherlock Gooch, fifth baronet. (*b*). Catherine Marion Sherlock Gooch. (*c*). JOHN SHERLOCK GOOCH, Major in the Royal Artillery, who married Ella Cecilia Piercy Drury, daughter of Ward Chipman Drury, of St. Johns, New Brunswick.

II. Eliza Gardner, born in 1806 ; married, in 1830, the Rev. John Buckner, M.A., of Wyke House, Sussex. He died in 1878, and his wife died in 1889. There were four sons and four daughters, the issue of this marriage, viz. :—

(1). Charles Buckner, *d.s.p.*
(2). Georgiana Buckner, who married —. Firminger, with issue.
(3). Minnie Buckner, married —. Sale, with issue.
(4). Augusta Buckner, married —. Gascoyne, with issue.
(5). Anne Buckner.
(6). JOHN BUCKNER, R.N.
(7). WILLIAM BUCKNER, R.N., married.
(8). Richard Buckner.

III. Susan Amie Anne Gardner, born in 1810 ; married in 1829, at Malta, Lieut. JOHN JAMES, born in 1807, 85th Foot, of Shelford, near Cambridge. He retired from the Army as a Captain in 1837, after 12 years' service, to become a railway engineer, under Isambard Brunel. He took part in the making of the Great Western, Bristol and Bridgwater, Taunton and Exeter, and other railways ; he was consequently frequently shifting his home to suit his work. He was a great sportsman, fishing, shooting, hunting, and tandem driving being his favourite amusements. He died from the effects of an accident in the hunting field, in 1850, at the comparatively early age of 42 years. His widow survived him more than 40 years. She died and was buried at Bournemouth in 1891.

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Their family consisted of eight children, three sons and five daughters :—

(1). The eldest child, Margaret Louisa James, born in 1830, was unmarried, and died in 1892.

(2). JOHN WILLIAM JAMES, born in 1831, was a Captain in the Navy. He married his cousin, Eleanor Gardner, and died in 1877, leaving no issue. His widow died in 1892.

(3). EDWARD RENOUARD JAMES, born in 1833, entered the Corps of Royal Engineers in December, 1851, and retired as a Major-General in October, 1882. He married, first, Eleanor Fawcett, and had issue one child, (*a*), Eleanor Amie James, born in 1864; second, Sophia Penrose Coode, in 1891. He died on the 14th October last. His services will be separately noticed.

(4). Henry Gardner James, born in 1835; married Catherine Lucy Duncan, with issue, a daughter, (*a*), Marguerite, born in 1875. He died in 1887.

(5). Julia Maria James, born in 1840; unmarried.

(6). Catherine Lydia Mackenzie James, born in 1842; married her cousin, Capt. T. S. GOOCH, R.N., who died in 1897. (See I. Anne Europa Gardner).

(7). Amie Augusta James, born in 1844; married Albert Vandendriesche.

(8). Alice Mary James, born in 1849, was unmarried.

IV. Mary Elizabeth Gardner, died, unmarried, in 1834.

V. WILLIAM BETHELL GARDNER, eldest son of the General, was born in 1815. He was commissioned in the Royal Artillery in 1834. He married in 1840, at Fort St. George, Inverness, Eliza Augusta Anderson, eldest daughter, and co-heir of Colonel Sir Alexander Anderson, C.B. He retired as a Major-General in 1867, and died in 1880. His wife died in 1878. There were 12 children of the marriage —four sons and eight daughters, viz. :—

(1). William Gordon Anderson Gardner, born in 1841.

(2). ALAN GARDNER, born in 1842, served in the Royal Navy. He married, in 1875, Sarah Frances Geddes, daughter of Alexander Geddes. He died in January, 1879.

(3). Eliza Gardner, born in 1845.

(4). Alexander Gardner, died in 1849.

(5). Agnes Gardner, born in 1847.

(6). Susan Gardner, born in 1849.

(7). Mary Gardner, died 1871.

(8). Henry Gardner, died 1854.

(9). Harriette Gardner, born in 1855; married, in 1875, T. Price.

(10). Augusta Gardner, died 1873.

(11). Bertha Gardner, died 1879.

(12). Millicent Gardner, born in 1861; married, in 1882, Donald Cameron, and had issue, (*a*), Sheila Cameron, born in 1884.

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VI. ALAN HENRY GARDNER, born 25th August, 1817, Rear Admiral, R.N., and C.B.; married, on 3rd January, 1860, Amy Sophia Elwes, third daughter of John Payne Elwes, of Stoke College, Clare, Suffolk. He died 30th July, 1878, having had issue :—

(1). The Rev. Alan Edward Gardner, born in 1861, Vicar of Bathford, Somerset.

VII. EDWARD CORNWALL GARDNER, born 2nd May, 1820, was a Captain in the Hon. East India Company's Service. He married, on the 14th April, 1843, Louisa Bonamy, daughter of John Bonamy, of Guernsey. He was killed in the second Burmese war in November, 1852, leaving issue :—

(1). Edward Bonamy Gardner, who died in 1864.

(2). Louisa Ellen Gardner, born in 1846; married, in 1877, Lieut.-Colonel BENJAMIN GEORGE HUMFREY, formerly of the 10th Bombay N.I.

(3). Alan Gardner, born in 1849.

(4). Frances Elizabeth Gardner, born in 1850; married, in 1884, Edward Godfrey Seymour Luscombe.

VIII. HERBERT CALTHORPE GARDNER, born 30th August, 1822, Captain in the Hon. East India Company's Service; married, in 1853, Emma Elizabeth Prescott, eldest daughter of Frederick Joseph Prescott, of Oxford Square, London. He died on 28th June, 1857, leaving issue :—

(1). Herbert Prescott Gardner, born in 1854. He settled in Queensland, Australia.

(2). Emma Louisa Gardner, born in 1857. She married, in 1882, James Lindsay Travers, and had issue :—(*a*). James Lindsay Travers, born in 1883. (*b*). Gladys Oliveria Travers, born in 1883. (*c*). Jessie Travers, born in 1886. (*d*). Herbert Gardner Travers, born in 1891. (*e*). Alice Travers, born in 1893.

IX. Augusta Sophia Gardner, born in 1824; married, on 27th August, 1844, Ponsonby Arthur Moore, born in 1816, who died on 3rd May, 1871, having had issue, a son and two daughters :—

(1). Ponsonby William Moore, born on the 29th April, 1846, who succeeded in 1892, as 9th Earl of Drogheda, to his cousin, the 3rd and last Marquis of Drogheda. He married, in 1879, Annie Tower Moir, daughter of George Moir, LL.D., and had issue :—(*a*). Henry Charles Ponsonby Moore, born 21st April, 1884, now 10th Earl of Drogheda. (*b*). Beatrice Ponsonby Moore, born 29th March, 1883.

(2). Lady Agnes Alexandrina Moore, born in 1848; married, in 1873, Sir Robert Anderson, K.C.B., Barrister, Assistant Commissioner of Metropolitan Police, and Head of the Criminal Investigation Department (1888 to 1901), and has had issue :—(*a*). Arthur Ponsonby Moore, born in 1874. (*b*). Alan Seymour Moore Anderson, born in 1876. (*c*). Walter Graham Moore Anderson, born in 1877. (*d*). Matthew Edmond Moore Anderson, born in 1880. (*e*). Alice Mary Agneta Moore Anderson, born in 1885.

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(3). Lady Alice Mary Moore, born in 1850; married, in 1870, the Rev. T. Russell Wade. She died in 1871, without issue.

X. HENRY FFARINGTON GARDNER, born 15th May, 1827, was in the Hon. East India Company's Service. He died in 1855.

I fear that the particulars of the descendants of Lieut.-General William Fyers, Colonel Commandant, R.E., which are given after each of the four children of the General referred to in the preceding pages, may be found rather tedious reading for those who are not specially interested in the family, but in that case they will be very naturally skipped. Nevertheless, they are remarkable, not only as showing a notable fecundity in the family, but as recording a wonderful array of sailors and soldiers furnished for the services of the state.

Thus, from four children of the General, the following numbers of officers of the Navy and Army have sprung :—

From Major-General Thomas Fyers	1	officers,	Navy.
	2	,,	Cavalry.
	4	,,	Artillery.
	3	,,	Engineers.
	3	,,	Infantry.
Total	13	,,	Navy and Army.
From Sarah Fyers, wife of Major-General C. Mann, R.E., ...	3	,,	Navy.
	1	,,	Cavalry.
	1	,,	Artillery.
	4	,,	Engineers.
	2	,,	Infantry.
Total	11	,,	Navy and Army.
From Charlotte Fyers, wife of Vice-Admiral James Young, R.N.	4	,,	Navy.
	2	,,	Artillery.
	4	,,	Infantry.
Total	10	,,	Navy and Army.
From Elizabeth Lydia Fyers, wife of General the Hon. W. H. Gardner, Colonel Commandant, R.A.	6	,,	Navy.
	2	,,	Artillery.
	1	,,	Engineers.
	3	,,	Infantry.
Total	12	,,	Navy and Army.
Grand total	46	officers,	Navy and Army.

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So that, including the two sons of Lieut.-General William Fyers—Major-General Thomas Fyers, R.E., and Major Edward Fyers, R.E.—there have descended from that officer :—

14	officers	of	the	Royal Navy.
3	,,	,,	,,	Cavalry (including Indian Army).
9	,,	,,	,,	Royal Artillery (including Indian).
10	,,	,,	,,	Royal Engineers.
12	,,	,,	,,	Infantry (including Indian Army).
Total 48	officers	of	the	Navy and Army.

Before going on to an account of the children and descendants of Major-General Peter Fyers, C.B., Colonel Commandant, Royal Artillery, some further particulars of that officer himself, to supplement the rather bald sketch of his career I gave in an earlier part of this paper, will be found, I venture to think, of interest. A grandson of Major-General Peter Fyers, Major Evan Fyers, who has been most kind in assisting me in this part of my paper, has called my attention to *Memoirs of Lord Nelson*, by Joshua White, Esq., of which a third edition was published in London in 1806, and has sent me some notes.

In this third edition appears an advertisement by the author, returning his most grateful thanks to all who had favoured him with communications for the new edition. In this advertisement he says :—

"To Capt. Peter Fyers, of the Royal Artillery, who combines the urbanity of the gentleman with the ingenuity of the artist, his acknowledgments are particularly due. By that officer, who lived for a considerable time on the most familiar footing with Lord Nelson, the author has been favoured not only with many new and important details relative to the engagement before Copenhagen, but the public is likewise indebted to the friendly interest he has taken in the success of this work for a view of the line of defence which protected the Danish metropolis. The sketch from which it is copied was drawn by Capt. Fyers when, in the capacity of Chief Engineer, he accompanied Sir Hyde Parker, Lord Nelson, and the other officers who reconnoitred the Danish line previous to the attack; and, as all the other representations were made up from memory after the action, it is obvious that this circumstance must attach a peculiar value to the engraving now presented to the public, on account of its superior accuracy and truth."

In the narrative of the attack on Copenhagen in 1801 it is stated that immediately after the whole fleet had anchored off Copenhagen, Sir Hyde Parker, Lord Nelson, Capt. Freemantle, Colonel Stewart, the Captain of the Fleet, and Capt. Fyers, Acting Engineer to the Expedition, went in a lugger to reconnoitre the enemy's force. They

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persevered in sounding, in spite of a heavy fire opened upon them by the Danes, "until they were satisfied," when they returned to their respective ships. It was on this occasion that the sketch, already referred to, was made, from which the engraving that faces p. 183 in the book was executed.

In a footnote to p. 216 is the following passage :—

"Among the officers who were particularly distinguished by the notice and esteem of Lord Nelson was Capt. Peter Fyers, of the Royal Artillery. . . . In the year 1800 Capt. Peter Fyers, having five bomb-ships under his command, was sent to the Baltic with Admiral Sir Archibald Dickson, in order that the appearance of these vessels off the city of Copenhagen might give weight to the negociations then carrying on by Lord Whitworth, our ambassador at the Danish Court, in consequence of a dispute, which his lordship succeeded in adjusting in an amicable manner.

"On the arrival of Capt. Fyers at Copenhagen, he was invited by Lord Whitworth to his hotel, where he remained about a week. During this interval he availed himself of every opportunity to make himself acquainted with the strength and resources of Denmark, and to obtain such information as might be useful in case of future hostilities with that country. Soon after his return to England his country had occasion to avail itself of the intelligence he had fortunately been so indefatigable in acquiring. He received directions to accompany the armament which sailed in March, 1801, under the command of Sir Hyde Parker, from whom he received the appointment of Acting Engineer to the Expedition."

The following is a copy of the document making the appointment :—

"By Sir Hyde Parker, Knight, Admiral of the Blue, and Commander-in-Chief of a squadron of His Majesty's ships and vessels employed, and to be employed, in the North Sea, and on a particular service.

"Whereas I think it will be highly beneficial to the public service that an engineer should be appointed to the present expedition, not only for the purpose of taking sketches of the coasts, islands, etc., etc., but to do all other duties when landed, otherwise belonging to and required of an Engineer.

"You are hereby required and directed, in addition to your present employment as commanding officer of the Artillery, to take upon you that of an Engineer on the present expedition accordingly.

"Given on board His Majesty's ship *London* at sea, 12 March, 1801.

"H. PARKER.

"Capt. Fyers, of His Majesty's Royal Artillery, ordered to act as Engineer on the present expedition.

"By command of the Admiral,

"B. OSBORN."

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On the 31st March, Capt. Fyers, in company with the Admirals, reconnoitred the Danish positions as already mentioned, and made the sketch referred to. A council of war was held on the following day, the 1st April, when a series of questions were put to Capt. Fyers, which are recorded, with their answers, and must have been communicated to the author by Capt. Fyers himself:—

"Q. Can you, with the bomb-ships under your command, get near enough to the city of Copenhagen, particularly to the dockyard, to bombard it to advantage, in spite of these vessels which the Danes have moved in front of the City?

"A. No. The Danish line of defence is so strong, in addition to their batteries, that the bomb-ships would be exposed to total destruction in the attempt, without any chance of success.

"Q. Can you bombard these vessels with such effect as to open to yourself a way to the bombardment of the dockyard?

"A. From the uncertain nature of mortar firing on board ship, it is very improbable that I could do them much harm, and in the attempt I should be expending the ammunition, the great object of which is the bombardment of the City.

"Q. How many of these vessels do you wish cleared away to enable you to get a proper berth with the bomb-ships?

"A. I think if seven of them to the southward were removed I should be enabled to get in so as to range over their dockyard; but the effectual bombardment of Copenhagen would be impossible, unless all of them to the southward of the Crown Islands were cleared away.

"Q. If the whole of them were removed, could you answer for the destruction of the City and dockyard?

"A. Every military, as well as naval, operation must be liable to failure. I cannot, therefore, *answer* for success, but I have the strongest reasons for believing it extremely probable."

It was decided to make the attack the following day. On the morning of the 2nd April, just before H.M.S. *Edgar* led in, Capt. Fyers, who was on board the *Elephant*, suggested to Lord Nelson that it might be of great advantage to have a few carcasses on board the *Elephant* and *Glatton* for their carronades. Lord Nelson at first objected that "his Jacks" would burn their fingers, not being accustomed to the use of carcasse shot. Fyers then proposed to send a proportion of carcasses on board these ships, accompanied by a careful gunner, with directions to instruct the seamen in their use. Nelson consented, and it was due to them that the Danish Commodore's ship, the *Dannebrog*, was set on fire and blew up.

The whole object of the battle of the 2nd April was to make way for the bomb-vessels to bombard the city, in order to compel the Danes to abandon their armed neutrality while the British fleet went for the Russians and Swedes in the Baltic. The destruction of the Danish ships composing the line of defence opened the way for Fyers and his bomb-vessels. These were seven in number, carrying

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14 mortars. They anchored within a mile of the dockyard; and the city, the dockyard, and the Danish fleet lay within their range. In this position Fyers remained for three days, every moment expecting a signal to open fire. Thus the compliance of Denmark with the terms offered became a matter of necessity, as the city, the dockyard, and the fleet were at the mercy of Fyers and his bomb-vessels.

After the action of Copenhagen, Lord Nelson presented Capt. Fyers, as a testimony of his friendship, with one of the medals given by him to the officers who served at the Battle of the Nile; also with a print of his head, which Nelson thought more like than any other, and desired Fyers to keep in remembrance of him.* On the return of Sir Hyde Parker to England, Lord Nelson, having succeeded to the chief command, sent a note and his barge to Capt. Fyers, who was most uncomfortably situated in the *Sulphur* bomb-vessel, desiring that he would bring his baggage and swing his cot on board the *St. George*, where Lord Nelson hoped he would live at his table, and take a trip with him to Revel, whither he was going immediately with seven sail of the line. Fyers accepted the invitation gladly, and for three months he was Lord Nelson's guest, experiencing "the greatest affability and kindness" on board the *St. George*, and afterwards in the *Medusa*, on which frigate Lord Nelson hoisted his flag during the Expedition to Boulogne.

In the first attack on the flotilla at Boulogne, Capt. Fyers was wounded in the thigh. The following letters and order of the day, written by Lord Nelson, refer to Fyers and the bomb-vessels :—

"To Esau Nepean, Esq., Admiralty.

"*Medusa*, August 4th, 1801.

"Sir,

"The Enemy's Vessels, Brigs, and Flats (Lugger-rigged) and a Schooner, twenty-four in number, were this morning, at daylight, anchored in a line in front of the Town of Boulogne. The wind being favourable for the Bombs to act, I made the signal for them to weigh, and to throw Shells at the Vessels; but as little as possible to annoy the Town . . .

"The Officers of the Artillery threw the Shells with great skill; and I am sorry to say that Capt. Fyers, of the Royal Artillery, is slightly wounded in the thigh, by the bursting of an Enemy's Shell, and three Seamen are also wounded.

"I am, etc.,

"Nelson and Bronte.

"One more of the Enemy's Flats is this moment sunk."

* The original was drawn from life on 8th December, 1800, by de Koster. There is a copy of it in the Royal United Service Institution Museum in Whitehall. Nelson himself wrote of it from Merton on the 2nd February, 1802 :—"There are so many prints of me that it is not in my power to say which is most like the original, for no one of them is like the other, but I rather think a little outline of the head sold at Brydon's, Charing Cross, is the most like me."

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"To the Squadron.

"5th August, 1801.

"Lord Nelson has reason to be very much satisfied with the Captains of the Bombs, for their placing of the Vessels yesterday. It was impossible that they could have been better situated; and the Artillery Officers have shown great skill in entirely disabling ten of the Armed Vessels out of twenty-four opposed to them, and many others, Lord Nelson believes are much damaged. . . .

"Nelson and Bronte."

"To Admiral the Earl of St. Vincent, K.B.

"6th August, 1801.

"My Lord,

"The wind being easterly, I have determined to give up for a few days my visit to Flushing, and to do my utmost to get the Fencibles afloat . . .

"Capt. Fyers' wound is so very painful, that I am sending him to Deal; I am sorry, at this moment, to lose the services of so useful and zealous an officer. Again and again, I congratulate and rejoice with you on Sir James Saumarez's success.* No small degree of merit must attach itself to your Lordship for nicking the time of sending out that squadron.

"I am, etc.,

"Nelson and Bronte."

Space does not admit of further quotations from despatches bearing on the services of Capt. Peter Fyers under Lord Nelson at Boulogne. References to these may be found in *Despatches and Letters of Lord Nelson*, by Sir N. Nicholas. London, 1845. Vol. IV., pp. 432 to 445.

During the time of repose, when Capt. Fyers was recovering from the effects of his wound, which was more serious than at first supposed, he amused himself by superintending the engraving of his drawing of the Danish line of defence at Copenhagen. The publication of this print seems to have excited a good deal of interest, as the following letters from Lords Nelson and St. Vincent show :—

"Merton, Surrey, April 8th, 1802.

"My Dear Sir,

"Colonel Suckling has just told me that he has the pleasure of knowing you, and that you had given him reason to believe that you intended favouring me with a visit before your going into Scotland. My relation also tells me that he has seen a proof print of your drawing of the Danish line, which we are all very anxious should come out. It can give offence to no party. Sir Hyde, Freemantle, Colonel Stewart, Doyle, etc., are all enquiring why it is not out. Therefore I have to request you will be so

* The success alluded to is the victory over the combined French and Spanish squadrons off Gibraltar on the night of 12th–13th of the previous month, referred to at length by Sarah Fyers, and celebrated at Gibraltar on her wedding day (see *R.E. Journal* for October last).

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good as to tell me who your engraver is, and also the name and abode of your friend who has the management of the print. It will, I am sure, do well. I am glad to hear you suffer no inconvenience from the wound in your thigh. You would regret sincerely the loss of Parker. Longford, I am fearful, will lose his leg. He is still confined by bones continually coming away. With every good wish, believe me, my dear Sir, your much obliged,

"NELSON AND BRONTE.

"CAPT. FYERS, Royal Artillery."

Earl St. Vincent, then First Lord of the Admiralty, on receiving a copy of the print, wrote :—

"I return you many thanks for the engraving of your drawing of the line of defence before Copenhagen, and for the honor of the dedication. I had great pleasure in stating to the Master General of the Ordnance, your meritorious services in the Baltic, which his lordship paid all the attention to that your most sanguine wishes could have taught you to expect."

At a much later date Colonel Peter Fyers published a book of lithographed reproductions of his Sketches of the Highlands, and having sent a copy to Sir Walter Scott, he received the following letter :—

"Sir Walter Scott's respectful compliments to Colonel Fyers, and is greatly obliged to him for the copy which he has received of the picturesque scenery of Loch Lomond and its vicinity, which has vividly recalled to Sir Walter a long train of half-forgotten circumstances of former days. The drawings are done with great spirit and accuracy, if a very unskillful person may presume to judge, and Sir Walter has no doubt that the work will be considered as acceptable to the public as it is creditable to the artist.

"Shundwick Place,
"29th May."

(*To be continued*).

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TRANSCRIPT.

THE FINAL STRUGGLE FOR 203-METRE HILL AT PORT ARTHUR.

Translation of an article by Staff-Capt. Kostiushko in the March, April, and May numbers of the *Eenzhenernee Zhoornal.*

(*Continued*).

30*th November.*—During the night the Japanese again made a demonstration in the direction of Pigeon Bay, but without results. At 5.30 a.m. it was noticed that the enemy were cutting the wire entanglement on the southern slope of Visokaya Hill, and in other places where it had been repaired with so much trouble overnight.

The Japanese artillery fire increased in volume before 7 a.m., and on this day it attained the most enormous proportions. On the 30th they both shelled and assaulted the hill in the most determined manner, and neither before nor after did they make such exertions to capture it as on this day.

The weather was clear and sunny; in the still air the constant bursting of the shells completely hid the upper slopes of the hill in clouds of smoke and dust. The hills re-echoed with the explosions of shells, the crackling of machine guns, and the volleys and rapid fire of rifles. General Kondratenko arrived early at the 5th Regiment Headquarters, and through field glasses followed the progress of the fight on Visokaya. Company after company of reinforcements, now almost exclusively composed of sailors, kept on coming up. The telephonists received so many messages from various points along the land front, reporting the fact that from all sides the Japanese were seen to be moving on Visokaya, that they had no time to write them down and despatch them.

At 8 a.m. a desperate attack took place, and the weak point was again the left redoubt. Its defenders were overwhelmed and the Japanese established their flag on it. General Irman, noticing this through his field glasses, sent orders by telephone to "at once drive the Japanese from the left redoubt," and despatched at 8.35 a company of the 28th Regiment, and at 8.45 a company of sailors.

Meanwhile General Tretyakov had already sent the reserves which were with him, in counter-attack against the left redoubt, and the Japanese were driven out. At other points the Russians held their own, yet the Japanese did not retreat, but kept on climbing and planting their flags at various points on the hill, were driven down again, and yet again clambered up with astonishing determination. It is difficult to say how many attacks

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were carried out at this time, in fact it was one uninterrupted attack from dawn to midday. Fresh companies came up and melted away with surprising rapidity. The officers of the newly arriving companies were ignorant of the arrangement of the trenches, and consequently General Tretyakov himself had to show them the way and lead their companies into the fight. With marked rapidity and skill he led fresh troops to the most important and dangerous points, and to his action it is due that this most determined assault was gloriously repulsed. His most able assistants at this time were Capt. Stempnevski and Ensign Ermakov.

So many shells fell on the top and the rear slope of Visokaya, that the wires connecting the hill with the 5th Regiment Headquarters and with the town were broken several times. The behaviour of the men of the telegraph company was beyond all praise, and again and again, under heavy fire, they repaired the damage and restored communication. Several of them were decorated on the spot by General Kondratenko for their bravery.

When the telephone was out of action, reports were sent by mounted volunteers. For instance, at 10.30 a.m., when affairs on Visokaya were in a very alarming state, General Tretyakov desired to get into conversation by telephone with General Kondratenko at the 5th Regiment Headquarters. He had just reached the telephone (commandant's) blindage when an 11″ shell fell so near that it damaged the roof of the blindage and cut the wire.

On this General Tretyakov called a mounted volunteer, and sent by him an urgent message that the trenches were wrecked, losses heavy, and reinforcements necessary. As no paper was ready to hand, he wrote this message on a stone.

Owing to the necessity of economizing shells, the Russian artillery was unable to engage with that of the Japanese, and fired comparatively seldom, and then generally at the attacking infantry. The Japanese artillery consequently paid little attention to concealment from view or cover from fire, and, posted within easy range, were able to shell the Russian trenches point blank from morning till night, thereby adding considerably to the difficulties of the defenders. As many as 30 field and mountain guns stood in the open, on the spurs of the Jagged Hills, and in the ravine near Louisa Bay. A Japanese battery standing on Long Hill, at a distance of 1 to 1⅓ miles from the trenches of Flat Hill, caused particular annoyance.

Picture to yourself the state of mind of a rifleman sitting in a trench which is under continual fire from a battery from morning to night. The dust rises in a thick column and fragments of sand-bags fly in all directions. He sees one after another of his brave comrades perish without being able to cause any hurt to the enemy, and with bitterness in his soul awaits his turn to die like his comrades, ingloriously, unnoticed.

The enemy is meanwhile suffering no loss, rifle bullets will not reach him, and the artillery is silent. The rifleman prays to Heaven that the enemy will attack, so that he may at any rate have the satisfaction of seeing them, firing at them, and possibly killing or wounding some of them. But they sit quietly in their trenches at 30 to 50 paces away, and

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wait until their artillery shall finally have wrecked the trenches and killed all the defenders.

Of course the men, through their officers, sent urgent entreaties to the artillery to shell such and such a battery and sweep it out of existence. Messages of this description daily came in without end to the head-quarters of the 5th Regiment from various parts of the position, and were passed on at once to the various forts, entrenchments, and batteries. But they were not complied with, as General Biely, finding that his shells were running short, had limited all guns to five rounds each per diem. During the main attacks more rounds were fired, but only with special permission from General Biely. Only the Baranov and the Hotchkiss guns had plenty of shells, but these guns were of small range, and the Baranov guns had the additional objection that they used black powder, and the smoke at once disclosed their positions. Consequently in a work with five or six guns, the artillery commander had to limit himself to firing only from 25 to 30 shells daily, and he therefore considered it his duty not to be drawn into firing at small targets, but to reserve his allowance for use against storming columns, and, with every desire to help the infantry, was obliged to refuse to fire at their request. Occasionally one would take pity and fire two or three rounds, but although naturally these few rounds would do little harm to the enemy, nothing could exceed the delight of the riflemen in the trench. They would exclaim "God bless and preserve that battery!" and with this small encouragement would accomplish their painful, unseen tasks with fresh courage.

To add to the troubles with which these hardly-tried men were overwhelmed, their very trust in their rifles in this miserable fighting went from bad to worse. Cases occurred in almost every company when, at the moment of a Japanese attack, some rifle refused to act. One can hardly appreciate the horror of a soldier who in a critical moment finds that his rifle, his one and only hope, has failed him. This was caused by the fact that the bursting shells filled the air with smoke and dust, which, in the course of a prolonged bombardment, was driven in such quantity into the mechanism of the rifle that it often made it impossible to turn the bolt.

The Japanese, who were waiting quietly in their parallels at a distance of some 30 paces from the trench, would seize a favourable moment and rush forward to the attack. The Russian riflemen, whose arms were kept ready loaded, were able to fire one shot (though this was not invariably the case, for there were many misfires), but on attempting to re-load they would find that they were unable to work their bolts, and so were obliged to rush upon the enemy with the bayonet, without first weakening him with their fire.

And so the men lost confidence in their rifles and took the more willingly to hand grenades, which did not fail them at the critical moment. By the 30th November they had taken such a liking to them that they used them almost exclusively, and with great success, in repelling attacks. On that date alone as many as 7,000 were used on Visokaya Hill alone, and as this expenditure was greatly in excess of the supply, General

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Kondratenko, when deciding to send up the seventh thousand, begged the men not to waste them, but to economize them as much as possible. The word "begged" is used intentionally, for the ordinary form of General Kondratenko's orders was "Please, such a one, I beg of you to do so and so."

The grenades were mostly made in the workshop of Lieut. Melik-Parsadanov, but naval Lieuts. Podgurski, Vlasiev, and others also made them, and 800 were prepared by Ensign Ermakov.

The bright sunshine on the 30th November inspired everyone with confidence and a firm belief in success. Each worked honestly, fearlessly, with a feeling that the luck was with him. The gallantry both of the riflemen--especially those of the 5th Regiment, who felt that they must maintain their splendid record and show themselves braver than the rest in the presence of their commanding officer—and of the sailors, was unceasing. A circumstance which contributed to this good result was that, whether acting on his own initiative or on a hint from General Kondratenko, General Stessel sent the former more than a hundred decorations of the Military Order, with which to reward on the spot any who distinguished themselves. This idea gave brilliant results.

At the beginning of the war the men who came into notice in sorties and by deeds of valour, and the wounded who returned to the ranks, were recommended for decorations, but the recommendations were pigeon-holed by the various staffs. For example, those of the 5th Regiment, some dating even from August, were resting peacefully in the headquarters of the 4th Division, and were eventually collected by Colonel Dmitrevski, the chief of the staff of that division, and sent back to the regiment to be arranged in a general roll by companies, and in chronological order of the fighting. It was bad luck that the few invalid clerks, who could be spared from the ranks for work in the 5th Regiment office, had to sit up all night to complete the list, but it was a still greater misfortune that the men, not receiving their rewards and hearing grumbling in the dug-outs at the staffs and headquarter offices, began to lose the hope of ever getting any rewards, and when they saw cases of less distinguished men elsewhere receiving rewards, they lost confidence in the justice of the authorities in considering their actions. "*Bis dat qui cito dat.*" Men volunteered for dangerous enterprises, dreaming that if they escaped alive they would adorn their breasts with the valued crosses of St. George. They performed the exploits, returned alive, were recommended . . . and time passed and the rewards remained a dream! Almost everyone had distinguished himself somewhere, and yet no one had got anything. They felt injured, and ceased to volunteer for sorties. They began to say straight out "Where there are no rewards, do not ask for volunteers; we will go in our turn." And yet the whole success of sorties depends on the men being volunteers, as these alone have the necessary pluck.

In this connection the following order, published by the staff of the 4th Division, may be mentioned:—"Only attacks are to be counted as fighting; the daily interchange of firing is not to be so considered.—Colonel Dmitrevski." It was consequently forbidden to recommend for

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decoration wounded men who remained in the ranks during the daily firing, although by their action they ran the risk of being killed or again wounded.

But as soon as the men saw the possibility of obtaining rewards without endless delays, there awoke in them a fresh desire for distinction, and men seriously wounded went back to the ranks after having their wounds dressed, while the numbers who offered themselves as volunteers for even the most dangerous enterprises were so large that it became necessary to cast lots to decide who should be taken.

Tretyakov, to whom Kondratenko entrusted 30 of these crosses for distribution in any cases which might come under his observation, was able to report as follows:—"Crowds of wounded are returning to the ranks, and many men are volunteering for the most dangerous undertakings. Those who have received decorations, by their courage and self-sacrifice, are splendidly influencing their comrades."

The fighting on Visokaya Hill excited the liveliest interest among the inhabitants of Arthur, and the streets of New Town were filled with watchers, who anxiously followed the progress of the fighting. The Commander-in-Chief was not satisfied with the reports of observers who were following the fighting with field glasses from the 5th Regiment Headquarters, but called for information by telephone from the hill itself, and also from Pigeon Bay, whence its western slopes were visible. With all attention so engrossed upon the fighting, Kondratenko did not forget the necessities of those under him, and made arrangements to provide for their wants.

Deeply regretting the error of the 28th November, when the rations had come up too late, he constantly enquired if the men had been fed and whether provisions had been sent up, and on the 29th November he secured a whole horse from the Supply Department, and arranged on the 30th for it to be boiled and cut up into rations, and in this form sent to Visokaya Hill, so that each man up there could draw his portion of bread and meat, and returning to his trench could eat it at his leisure. The value of this consideration was appreciated by the men who had been starving for several days.

At this time the men were getting half a pound of horse flesh twice a week, and on other days only plain porridge and tea, with bread or biscuits. During the fighting it was very seldom possible to get hot food, partly because only two men could be spared for work with the kitchen—a cook and his mate, one of whom had to draw the rations—and these were insufficient to get through the work, and, partly because when the food was ready the fighting prevented the men from attending to it, and when an interval of quiet occurred the food had disappeared, it had either gone bad or had been thrown away for want of vessels to keep it in.

The hot food also gave a lot of trouble, as the men had to go down the hill to get their rations from the kettles, and after eating it had to climb the hill again to their trenches. This took a lot of time, and during the fighting there was no time to spare; each minute was precious, as it was necessary to be constantly prepared to receive the enemy.

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Consequently Kondratenko's idea of issuing cold cooked rations proved very convenient, as two or three men were able to bring up the dinners for a whole company. The gratitude to the General of "his overworked and uncomplaining little warriors" knew no bounds.

In many treatises about Port Arthur (all of which, it must be admitted, emanated from one source) an incorrect idea is given of the services of General Kondratenko. The authors endeavour to give him the character of ably carrying out other men's ideas, but this is incorrect. The author of this narrative, who was present with Kondratenko frequently from morning to night in the 5th Regiment Headquarters, both saw and felt that all the wise and inspired arrangements made by him were attributable to himself, and to no one else. He usually first made the arrangements and afterwards reported them to his seniors.

After repulsing the attacks on this day, General Tretyakov was wounded in the back by a splinter and also bruised about the head; but recognizing how great a blow, both materially and morally, his departure would be for the garrison, he paid no attention to his wounds, but remained on the hill doing his duty and earning fresh distinction. When they tried to tell him that in the interests of his health he should go to have his wounds dressed, he answered that he could not consider himself at such a time, when the fate of his position, and incidentally of all Arthur, was in the balance, and that it was not in his power to abandon the hill on which his brave regiment was expiring.

The same shell which wounded the General also struck down the commandant of the hill, Capt. Stempnevski I. After beating off the assault of the Japanese, Tretyakov had just sent a report of what had occurred, and he and Stempnevski, with a few other officers, were standing in his look-out, looking back at a group of men who were collected round the dressing station under cover of the hill. Stempnevski, who had remained with the General and aided him most efficiently in repelling attacks, was in the act of making an entry in his note-book. He had been very careful in noting down every event as it had occurred on Visokaya Hill, and his note-book was a most valuable document, full of details of this historic defence; but, unfortunately, after he was wounded it was left in the telephone blindage, and eventually lost. And so this gallant and methodical worker was employing a spare moment in making notes of the attack just repulsed. Many of the wounded were also crowded close by, having their wounds rapidly seen to in a small niche.

Just then an 11" shell was heard overhead, and before anyone could move it struck the edge of the slope and burst with a deafening report almost in the middle of the group. The force of the explosion threw Tretyakov into the air and then dashed him down so fiercely that he did not at once recover his senses, covering him with earth and small stones. All around, in all sorts of attitudes, and lying one upon another, the whole group lay motionless, and underneath them lay Stempnevski. On all sides were heard groans and harrowing sighs. At the General's feet several of the men lay dead, and with them Ensign Reshetov, of the 2nd Company, 5th Regiment, and a white-coated naval engineer, sitting on the ground, clutching with both hands at his

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left groin, was crying aloud with unbearable pain. After about a minute the surgeons, with their assistants and any riflemen who happened to be at hand, were busying themselves among this heap of living human flesh.

General Tretyakov with some difficulty raised himself. They bore the engineer to the dressing station close by, and placed Stempnevski in the niche. The general went up to him and asked him "What has happened to you, Stanislav Julianovich?" "I am badly bruised in the back; I can hardly breathe," answered Stempnevski, closing his eyes. He lay pale and motionless, suffering severe pain. "You must be taken to the dressing station." "No, I beg," answered Stempnevski, and was left lying in the niche. After about an hour he was carried from the hill, and Tretyakov felt that he had indeed lost his right-hand man, for Stempnevski knew Visokaya Hill as no one else knew it, every blindage, every traverse, every yard of it, and therefore his loss was a grievous blow to the General.

By the heroic bravery of the riflemen and sailors, and above all by Tretyakov's skill in applying this quality of the men, and in sending them in timely support of the points where the danger was greatest, this most persistent attack was brilliantly repulsed, in spite of the overpowering superiority of the enemy in both infantry and artillery, and the perseverance with which they had pressed up the hill for four hours continuously. All Arthur rejoiced at the success, and the name of Tretyakov was brought into high esteem. General Kondratenko repeatedly called him "hero" and "brave man," and the 5th Regiment felt great pride in their commanding officer.

The Japanese, exhausted with their four hours' fighting, were driven back, and after midday drew off, and peace lasted for over an hour. Then again fighting burst out, at first artillery fire, and at about 3 p.m. the infantry again attacked Visokaya Hill, and, as in the morning, pressed up it with astonishing persistency. The Russians were so exhausted by their long fight without rest or food that they could hardly move, and for want of reinforcements their position became extremely critical.

As every man who could safely be taken had already been withdrawn from the neighbouring positions, General Irman decided upon a risky expedient, namely, to bring up immediately the 1st Foot Volunteer Detachment, 5th Regiment (80 men), from Entrenchment No. 4 to the 5th Regiment Headquarters.

General Kondratenko reported the want of reinforcements to the staff of the Kwantung Fortified Rayon. At 4.30 Colonel Reiss informed him by telephone that General Stessel advised him to take the fresh troops from Division Hill and replace them by the exhausted troops on Visokaya, as owing to the importance of the latter it would be better to sacrifice Division Hill or Panlunshan.

In accordance with this, the 3rd Company and half of the 7th Company, 5th Regiment, were at once sent for, and it was ordered that the trenches of the 3rd Company should be occupied by 49 men of the 9th Company, 27th Regiment, while those of the 7th Company, and also those

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from which the 5th Company had been removed on the 30th November, should be very thinly held by the remaining half of the 7th Company.

At 4.30 the following information was received by telephone at the headquarters, 5th Regiment:—"To General Kondratenko. Copy of Official Report No. 1937, from the Port Commander. The Port Commander communicates herewith news, collected from Chinese sources, that the Japanese will attack to-day and to-morrow, as these are their lucky days. Their killed number 11,000. From the north the Russians are advancing in relief; they took Samson and stormed Kinchow several days ago. The number of killed on both sides is very great, but the men keep up their spirits. The Russians have yellow epaulets and un-Russian faces.—Staff-Capt. Postnikov."

This news was at once passed on by telephone round the positions, but hardly anyone believed it. And yet the yellow epaulets were known to be the mark of the Trans-Baikal Cossacks, and the un-Russian faces seemed to confirm this, as the larger portion of the Trans-Baikal troops were Buryats, of Mongol race; while in Port Arthur there had been for some time confused rumours that a strong force under General Sakharov was advancing to their relief, and that this force included many Cossacks and cavalry generally.

It is not known who was responsible for spreading these rumours, but fresh ones appeared every minute in Arthur, and especially at first had a salutary effect upon the garrison. For example, in August, 1904, when the Japanese for a whole week had been attacking Port Arthur in a most persevering manner, and matters began to look bad for the defenders, news flew round the town that the Vladivostok squadron was bombarding the eastern coast of Japan, that they had burnt the Port of Yokohama, that in Tokio alarm was felt at the nearness of the Russian squadrons, that the Japanese could not get sufficient men to complete their armies, that they had no money for carrying on the war, that the people were murmuring against the increased taxation and would not take service in the armies, but demanded the immediate discontinuance of the war. It was also rumoured that a Japanese squadron had sunk a German ship, and that to hide all traces of their crime they had saved no one, but that a passing French ship had picked up three men, and now France and Germany were despatching their fleets to punish Japan and demand satisfaction. They said that the Russian Manchurian Army was pressing the Japanese from the north; that the Mikado did not know how to remedy his misfortunes, and ordered that Port Arthur should be taken at all hazards, in order that he might discuss conditions of peace with Russia on equal terms!

These rumours had appeared credible because the Vladivostok Squadron had already sunk a Japanese transport which was carrying siege artillery to Port Arthur, and from this everyone looked upon the Vladivostok sailors as heroes, to whom the bombarding of the Japanese coasts would present no extraordinary difficulties! Everyone willingly accepted the rumours, and the spirits of the garrison rose forthwith beyond all comprehension.

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Without attributing to these rumours the whole of the Russian success in repulsing the August attacks, it would not be fair to deny them a share in the general result.

But as time went on, and so far from being verified the rumours began to be replaced by the sad truth, they were less readily credited. There is no doubt that those in command at Arthur would have been glad to refrain from publishing these rumours, and would have revealed the truth to the garrison if the truth had been at all consoling!

And so on this occasion the favourable news did not produce on men harassed with this unequal struggle the strong impression which was intended, but there certainly were some who, if they did not believe, at any rate did not dispute the possibility of the approach of a Russian army from the north.

Meanwhile the fighting went on; Tretyakov in spite of his exhaustion made use of all available resources with extraordinary skill, and with incredibly small numbers somehow or other supported the mad onslaughts of the Japanese.

To add to their troubles the growing darkness further aggravated the difficulties of the defenders. Nerves harassed by the four days' fighting portrayed to the men all possible horrors. Thus those on the extreme flank kept on thinking that they were being turned; some saw Japanese already in their rear, and misled their commander by their unverified reports. About 9 p.m. the enemy looked like breaking off their attack, yet they did not retire, but lying down very near the Russian trenches, kept pelting them with grenades.

Tretyakov's report at this time to Irman gives a good idea of the condition of the defenders. This is what he said:—"The enemy are bombarding us heavily with grenades, and keep the men in a state of tension; it is quite impossible to work, the sailors are leaving their places without permission under various pretexts, in spite of orders. Unfortunately all detachments are intermingled, and the officers are ignorant of the ground and the positions of the trenches; for me personally things are very difficult, the men refuse to move, and, worst of all, I am utterly hoarse and deafened from my bruises."

The complaint against the sailors was really deserved by them, for, compared with the riflemen, they were less well disciplined and less enduring. On Visokaya Hill detachments were intermingled, many of the officers had fallen, and superintendence had fallen entirely on non-commissioned officers. The sailors did not like coming under their orders, and often utterly refused to obey them, which provoked quarrels and complaints. The sailors were brave; they charged boldly with the bayonet, and by their valour earned a splendid reputation; but when the Japanese fell back in order to rest and to weaken the Russian defence by the fire of their artillery, the sailors did not consider it their duty to sit still in the ruined trenches, and many of them went away under various pretexts.

During this fighting on Visokaya Hill, probably on the 1st December, cases occurred like the following:—General Tretyakov sent a company of sailors, under Midshipman Samoilov, to drive the Japanese from the

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left redoubt. The sailors went boldly to the attack and drove back the Japanese, but then they themselves dispersed. After an hour the General sent Ensign Ermakov with some order to the left redoubt. The latter went off, but came back again quickly with the report that there was no one there! Tretyakov promptly sent a section of riflemen from the reserve, and spent any amount of trouble and anxiety in looking for the sailors. On another day the same sailors again behaved gallantly in an attack, and again earned commendation.

The riflemen were also very brave, but they had not the *élan* of the sailors; this was not their fault, but due to the different conditions under which they were serving:—(1), The sailors were better clothed; (2), they were sent to work for definite periods, while the riflemen worked continuously, because the Japanese were always damaging their trenches. In these cases of course the sailors referred to are not those in companies and detachments which were always employed on the land front, as these served exactly like the riflemen, but those sailors who belonged to the ships, and who formed the general and last reserve, being only sent to the positions on the occasions of especially serious attacks; (3), the sailors were housed in barracks and the riflemen in the trenches; occasional shells flew over the barracks, but the trenches were subjected day and night to the fire of mines, shells, grenades, and machine guns, directed especially at them. The sailors' barracks were situated comparatively far away from the Japanese, while the attackers were within 15, or 30, or 50, or 100 paces of the trenches, so that the barracks were safe from those sudden attacks for which the trenches were only too conveniently situated. From this it will be seen that the riflemen, if they managed to sleep at all, had to do so always with one eye open. Their slumber was disturbed by shells bursting around them, and by the constant fear and anxiety of sudden attack. If the sailors' rest was short, they were able to enjoy it to the full. Their sleep was not disturbed by constant firing, they were not worried about sudden attacks! (4), Finally the sailors received each day salt beef with soup or broth, but the riflemen only twice in the week got a quarter of a pound of horse flesh with their porridge, and on the other five days plain porridge without meat. They improved it at first with Chinese vegetable oil, and later on when this was expended with something else, which the men called paste, but which they did not like, as it disagreed with them abominably.

By these unequal conditions of food, clothing, quarters, work, rest, etc., the riflemen were weakened, reduced in strength, and became so languid that they could hardly drag their feet along. Many found it a very difficult matter to climb the hill, and if it was difficult to move at all, it was considerably harder to advance to the attack. Recognizing this, they set the greatest value on the cover to be found in the trenches and feared to leave it for a moment; they grew accustomed to the arduous duty, and became trusty and experienced defenders of their trenches. There were no complaints that the riflemen left their posts without permission, but there were complaints against them of another kind—that they "refused to leave them"—through physical weakness.

The sailors, who had better preserved their physical strength, were the

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best troops for attack, but they were not used to the arduous duties of the trenches and did not recognize the necessity of sticking to their posts. They much preferred charging the enemy to sitting in trenches and perishing from artillery fire.

Besides these there remained a third class of fighting men, namely, those of the Hospital Detachments. The men who joined these detachments had long been accustomed to work among the sick and wounded, who had addressed them always in a most deferential manner. The hospital servants had treated their wounded comrades very unkindly, complying with their requests or not just as they felt inclined. But the wounded had not dared to complain for fear of making matters worse. Thus the hospital rank and file became full of conceit, and grew accustomed to having things their own way. They were practically unaccustomed to rifles, drill, or discipline. And all at once they were called upon to man the positions!

In the first place their companies had no cohesion. The men knew little of one another, and the higher ranks, officers and N.C.O.'s, knew less of those under them. And therefore complaints were made against the Hospital Detachments that they knew little of their work in the ranks and were not well disciplined. Complaints were also heard from the hospitals. The hospital men had been replaced by Town Guards, who knew nothing about the care of the wounded and had not learnt the hospital orders. They tried hard, but having no training they managed the new work badly and incurred complaints from the surgeons.

When he received the reports above mentioned, General Irman, with every desire to send up fresh troops, had not a single man in reserve. But within quarter of an hour the 1st Foot Volunteer Detachment, 5th Regiment, under Lieut. Vasiliev, came up from Entrenchment No. 4 and was immediately sent on to Visokaya Hill.

At 9.30 p.m. the Japanese repeated their attack. On this occasion General Tretyakov's report read as follows:—"The Japanese are advancing, the reserves are expended, the hill is in danger." The half 7th Company, 5th Regiment, under Ensign Moskvin, on arrival from Division Hill, was also sent to Visokaya. The 3rd Company (137 men) was sent to Flat Hill, but afterwards, when it was recognized that that hill stood in little danger, it was sent on to Visokaya.

Meanwhile, for want of reinforcements, neither personal bravery nor the activity of the General could stop the Japanese, who pushed back and overwhelmed the weak groups of the Russians, got on to the saddle, penetrated into the left redoubt, and were on the point of carrying the whole hill (see *Fig.* 5).

Tretyakov had been informed by telephone that reinforcements had been sent up, and he decided to maintain himself somehow. With incredible quickness he ran from one flank to the other, now here, now there, drawing together a few handfuls of riflemen and sailors, and leading them in counter-attack, by which he deceived the enemy, took away their confidence, and weakened their impetuosity. By these contrivances he stopped the advance of the Japanese, and when the rein-

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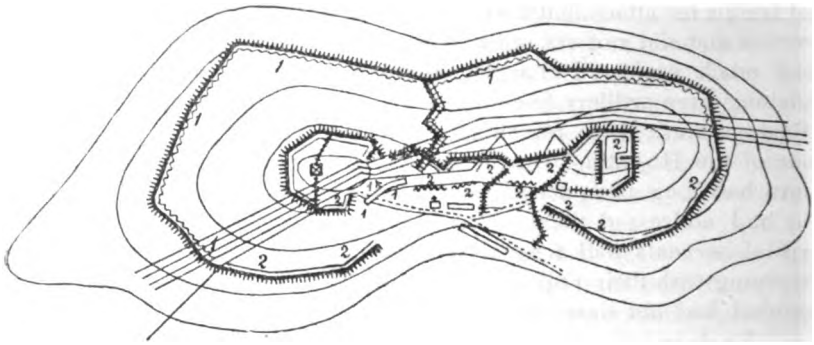

1—Japanese. 2—Russians. ΛΛ—Scene of the fighting.

FIG. 5.—*Condition of Visokaya at 9 p.m., 30th November, before the counter-attack.*

forcements arrived, himself took the offensive. He sent the 1st Volunteer Detachment to recapture the left redoubt, and occupied himself with restoring order in the centre. When the half of the 7th Company came up he was able to breathe more freely, and detaching part of the men to reinforce the right redoubt, he personally led the rest to drive the Japanese from the saddle.

The 1st Foot Volunteer Detachment, 5th Regiment, was formed under Lieut. Vasiliev immediately after mobilization. It consisted almost entirely of reservists from Vladivostok. The men were skilful and experienced, and Vasiliev welded them together and inspired them with his own heroic spirit. At Kinchow they suffered little, and were withdrawn, among the last, in perfect order. After this Vasiliev left them, having been appointed to a billet in connection with the regimental arms.

In the bayonet fight on Yupilaza Hill, on the 28th July, the detachment greatly distinguished itself, and lost 1 officer and 44 rank and file. In the subsequent fighting from 13th to 15th August, on Three-Headed Hill, it gallantly repulsed the enemy's attack, and charged several times with the bayonet, losing more than half its strength in killed and wounded. Since then the men had served under several commanders, all of whom had been wounded, in fact it is a curious coincidence that not one of its commanders was killed and not one escaped uninjured.

At one time they were commanded by Ensign (now Lieut.) Vakurin, who twice led sorties from Visokoya, and by blowing up a sap caused great loss to the Japanese. On the 21st October he was surrounded by them and severely wounded, but succeeded in getting away. On the 13th November, Lieut. Vasiliev was withdrawn from his duties in charge of arms to again take command of the detachment.

After their several days' rest in Entrenchment No. 4, the detachment arrived at Visokaya Hill looking fit and cheery. The order to drive the Japanese from the left redoubt gave promise of more bayonet work, with which they were all so well acquainted.

After a short and inspiring speech from General Tretyakov, and with their gallant commander at their head, they dashed forward with the

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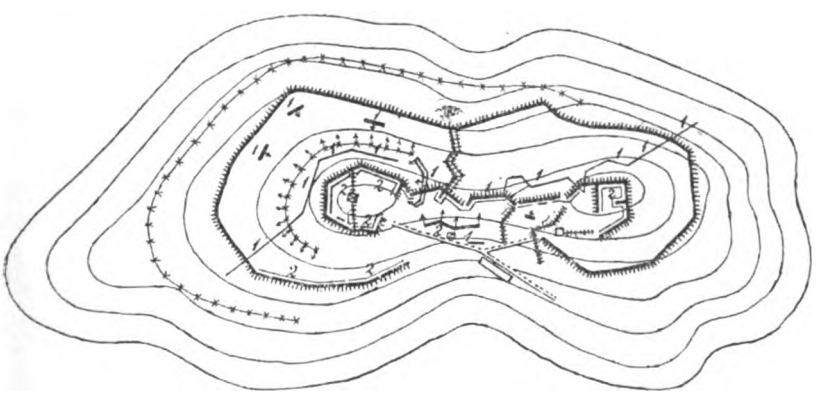
bayonet, thirsting to slay yet more of the Japanese. A wild yell rang over the hill as these 80 chosen fighters, like one man, fell upon the enemy before they could collect themselves and understand what was happening. Was it possible to resist such a united impetuous attack?

All the left crest and the left redoubt were cleared almost immediately. But the Japanese recovered themselves, collected together, and made several gallant attempts to retake the left redoubt; they came against it from three sides, but just then Tretyakov moved on to the saddle with a newly arrived detachment of 2 officers and 160 sailors from the *Retvisan*, and caught them in flank and overthrew them. In other parts also a hand-to-hand fight was going on.

General Tretyakov, in spite of his wound, showed great energy and ability, and once the left redoubt was firmly secured, success soon favoured the Russians, and the rest of the hill was again cleared of the Japanese (see *Fig.* 6).



1—Japanese. 2—Russians.

FIG. 6.—*Condition of Visokaya on 30th November, after the attack of 1st Volunteer Detachment and counter-attack of General Tretyakov.*

At about midnight the joyful news flew round Arthur and raised fresh enthusiasm. Many were the messages of congratulation which were sent to Tretyakov, Kondratenko, Irman, and the other heroes of Visokaya Hill.

After driving off the Japanese attacks on the left redoubt, Lieut. Vasiliev went round his section at the top of the hill, inspiring his men by his words and the example of his personal courage; but at a moment when he was giving some order, with his hat raised on high, a bullet struck him in the right shoulder, his hat fell from his hand, and his men lost their gallant commander. He was at once carried to the dressing station.

Many brave men fell in this unfortunate redoubt, but this must be considered as the price of the preservation of the hill. The Russian losses on the 30th November were very great. The senior surgeon of the 5th Regiment, Feodor Semenovich Troitsky, worked the whole day, from dawn to 10 p.m., in the dressing station under the hill, and

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attended to more than a thousand wounded men, after which he lost count. As the slightly wounded either remained in the ranks or went direct to the town without waiting at the dressing station, the total casualties may safely be taken at 2,000 men, or $\frac{8}{10}$ths of those engaged.

Although stretcher-bearers were summoned from every part of Arthur, yet they were unable to remove all the wounded, and drivers having been requisitioned from the town, some volunteer cyclists came up who, combining together in pairs, fastened stretchers between their machines, and in this way carried wounded men to the hospitals. Others got lifts on travelling kitchens and ammunition carts returning to the town, or found their way back in parties, helping one another along. Things were made all the more difficult for the wounded because the Tea Ravine was completely under fire from the Japanese on Visokaya, and movement along it became very dangerous. Cases occurred of wounded men being killed or again wounded in the ravine, and several horses, drivers, and stretcher-bearers were also hit while transporting the wounded to the hospitals in Arthur.

(*To be continued*).

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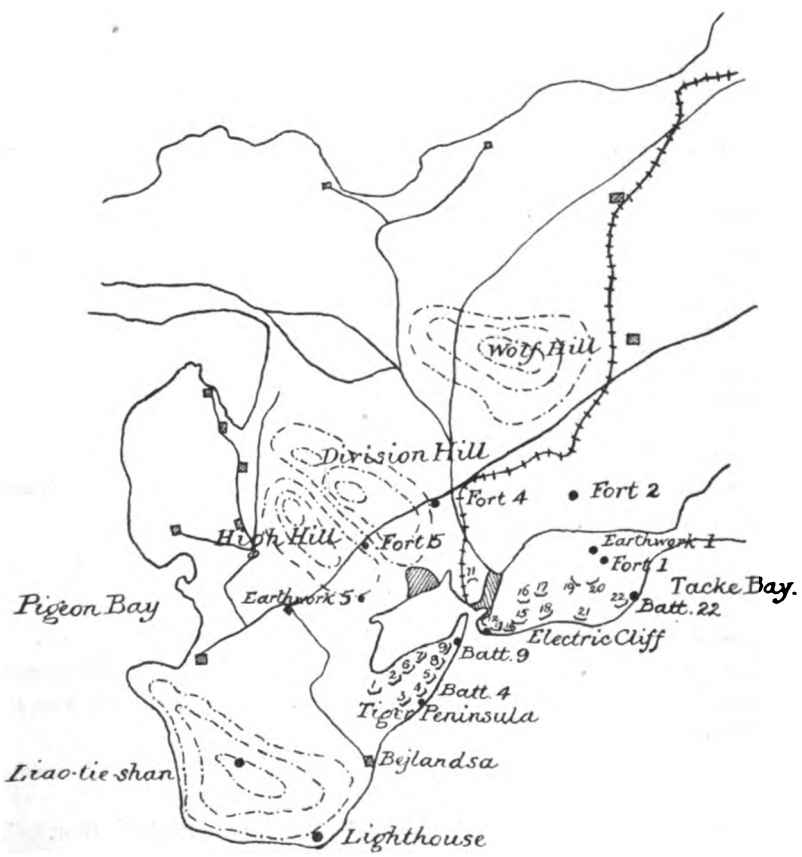
SEARCHLIGHTS: OTHER MEANS OF ILLUMINATION AND TELEPHONES AT PORT ARTHUR.

Translated from the *Mitteilungen über Gegenstände des Artillerie-und Geniewesens.*

1. Disposition of the Searchlights.

There were 12 electric lighting installations in Port Arthur, six for the land front and six for the sea. Three of these were taken from ships in the harbour.



Note. • - Searchlight.

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They were disposed as follows (see sketch) :—

Sea Front.

1.	Summit of Liaotieshan	90 c.m.
2.	Liaotieshan Lighthouse (naval light).	
3.	No. 4 Battery	90 c.m.
4.	No. 9 Battery	40 c.m.
5.	Electric Cliff Battery	90 c.m.
6.	No. 22 Battery	90 c.m.

Land Front.

1.	No. 1 Fort	90 c.m.
2.	No. 1 Earthwork	75 c.m. (naval).
3.	No. 2 Fort	90 c.m.
4.	No. 4 Fort	90 c.m.
5.	No. 5 Fort	75 c.m. (naval).
6.	No. 5 Earthwork	90 c.m.

2. NOTES ON THE LAMPS AND PLANT.

Electric Cliff and No. 22 Batteries, as well as Forts 1 and 2, had Schuckert arc lamps. The projector of No. 4 Battery had a Kutscherow arc lamp. In all these lamps the carbons were controlled automatically by an electro-magnetic mechanism. The power was supplied by 10-H.P. Nobel steam engines and Derozier dynamos, which supplied 80 ampères at 100 volts.

No. 4 Fort, No. 5 Earthwork, and the Liaotieshan Lighthouse had automatic Schuckert arc lamps, with Nobel petrol motors and Derozier dynamos.

No. 9 Battery had a 40-c.m. hand-worked arc lamp, with a movable steam engine and Siemens dynamo of 40 ampères and 60 volts.

No details are known of the three naval lamps at No. 1 Earthwork, No. 5 Fort, and the summit of Liaotieshan.

3. RANGE OF THE LIGHTS.

Experience showed that the range of the lights was as follows :—

90-c.m., 5 to 6 kilometres over sea ; 40-c.m. (naval), up to 3 kilometres over sea ; 75-c.m. (naval), no figures were obtained, as this light was used over land.

4. THE GENERATING PLANT.

The steam engines worked badly and often stopped altogether. The boilers had to be cleaned out every Monday, as the water used was hard and dirty. The Japanese had destroyed the waterworks, and the fresh water obtained from the filters was barely sufficient for the garrison. The petrol motors were old and had many breakdowns.

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5. The Searchlights on the Land Front.

The searchlights on the land front at Port Arthur had very exposed positions. As this allowed of their being easily destroyed, especially by any assaulting party, some expedient had to be adopted which would not only give the searchlights cover, but also enable them to illumine the ground close to the fortress. This was done by using tin-plate reflectors, on to which the beam of light was allowed to fall. The light itself was placed in a hollow, often with its back towards the attacker. This system was only used when the attack came close to the lights.

The absence of Iris shutters to shut off the light was found to be most inconvenient.

6. The Lights on the Sea Front.

There was no uniform control of the lights. An officer was allotted to each light, both to superintend the *personnel* and to observe any passing ships. The officers were however too independent of one another, went to work without any fixed system, and were not in communication with one another.

So as not to show up the guardship behind the boom, the lights of Nos. 4 and 9 Batteries had orders to search from the left up to the boom, and Electric Cliff light, from the right to the boom. All the other lights had to search the sea in front of them as follows:—Starting at their maximum depression, they swept from one limit to the other, then elevated a bit and came back, and so on, till the maximum elevation was reached. Thus the whole sea in front of the light was searched from quite close to the light to the limiting range. When a target was discovered the neighbouring lights were also directed on to it, partly to render its forward progress difficult by blinding the steersman, and partly to show it up to the guns. When several targets were discovered, the lights divided them up amongst themselves.

The light on Liaotieshan could not co-operate with that of No. 4 Battery, as its position only allowed it to illuminate the sea to the west and south-west of Liaotieshan.

7. The Desirable Number of Lights and their Distribution.

As can be seen by looking at the sketch, the large portion of sea to the S.W. of No. 4 Battery could only be illumined by the light near that battery, which also had to search the sea to the S. and E. of its position.

As has been already mentioned, the Liaotieshan Lighthouse projector could only illumine the sea to the W. and S. of its position, and, moreover, the beam on the top of Liaotieshan could only light up Pigeon Bay and the sea to its west. Thus a light at Bejlandsa village would have been most desirable, but unfortunately could not be obtained. It is however hard to understand why a searchlight from one of the ships

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lying useless in the harbour could not have been installed at Bejlandsa. Subsequently these lights went down with the ships they were on, and were thus lost. How useful such a light would have been was shown in the night 23rd—24th February, when two Japanese fireships came up unobserved from the south of Liaotieshan along the coast in the dead water of No. 4 Battery light up to the water opposite No. 5 Battery, when they were discovered by No. 9 Battery whose searchlight at this period was however not in working order.

Takhe Bay could only be occasionally lighted up by the beam of No. 22 Battery, and even this was not sufficient as there was dead water in the west of the bay. Probably it is due to this circumstance that the Russian torpedo boats, *Lieutenant Burakow* and *Bojewoj*—which were on night duty in the bay—were destroyed on the night 23rd—24th February by Japanese torpedo boats, which had crept unperceived along the coast.

No. 9 and Electric Cliff Battery lights could render but little assistance to No. 4 Battery light, as they had to form a "light obstacle" by crossing their beams. As they had however occasionally to search in other directions, the "light obstacle," or "illuminated area," was not continually in position. The efficiency of this "light obstacle," which was intended to blind attacking ships, was tested by Admiral Makarow himself in a tender and proved entirely successful, as the tender lost its course and was wrecked near Electric Cliff.

From the above it will be seen that the number of lights used was insufficient.

Roughly, considering the range of a 90-c.m. projector as 5 kilometres, the number of lights required can be obtained by dividing the length of coast to be defended by five. Provision must however also be made to illumine all bays and other parts of an irregular coast line. The lights intended for the "illuminated area" should have no other object and should be fixed. Other lights should be movable, or the enemy will make use of a knowledge of their position to steer by, as was here found to be the case from a map captured from the Japanese.

If the lights are not movable, they should be so numerous that alternative ones can be used, so that the enemy is deceived, and yet the illumination is the same.

For the "illuminated area" four lights are best, two in action and two in reserve. Experience showed that the best position of the lights was to one side of and below the battery. Observation from a point above the beam was found to be infinitely better to that from a point below it.

When batteries are situated so low that there is no possible position for a projector below them, the light should be placed well on one side of them.

8. Control of the Lights.

When the number of lights is so great that each battery can have its own beam, it should be controlled by the battery commander. When this is not the case, the lights should be allotted to groups of batteries, and each light placed under the orders of the commander of the group.

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The supreme control of the coast defence lights lies in the hands of the coast defence commander, who should be a coast artillery officer. The coast defence commander issues orders and instructions relative to the working of the lights when the enemy has been discovered, and draws up the scheme of changing the lights to deceive the enemy. When he orders a battery or group of batteries to open fire, he hands over to its commander the control of the lights allotted to it.

At Port Arthur there was unfortunately no such centralized control of the lights. The lights were not connected by telephone, and acted either independently or under the command of the commander of nearest battery, who directed them by means of signals on an electric bell, *e.g.*, one ring = swing right; two rings = swing left, etc.

Some of the lights were also occasionally placed under the command of the naval squadron commander, who was on board the battleship *Sebastopol* in the Eastern Harbour up to 10th August. Again, it often happened that torpedo boats returned the same night as they went out. As however nobody but the admiral and naval officer of the day knew the secret signs they were to give to show they were friendly, the batteries had to remain undecided whether to open fire or not until the sign had been obtained from the naval officer on duty in the harbour, and much valuable time was thus wasted. It is believed that the Russian torpedo boat *Silnyj*, which was destroyed on the occasion of a Japanese fireship attack, was probably sunk by Russian batteries, which had no means of readily distinguishing friend from foe.

9. A Suggested Means of Making Use of an Unilluminated Angle.

The following suggestion was made at Port Arthur, but was not put to a practical test:—

Two neighbouring lights agree only to light up to definite limits, so as to leave an unilluminated piece of sea between them, in which one or more torpedo boats assemble. As soon as a hostile ship appears they make for it, taking care however to remain in the dead angle. On reaching a suitable range, or on being discovered, the torpedo boats open fire. If they are unsuccessful, they show their lights, send up a rocket, and return to harbour, whilst the coast batteries open fire on the target.

10. Means of Illumination for Night Work of the Fortress.

In Port Arthur these consisted solely of petroleum lamps or candles, which were both inconvenient and inefficient, and further led to several accidents in the darkness.

11. Telephonic Communication.

The telephone lines in Port Arthur belonged partly to the artillery and partly to the engineers. Owing to lack of *personnel*, only some of the lines could be used.

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The communication was very bad, and men were often seen running from one telephone station to another carrying messages. A battery had often to ring up several exchanges to get into communication with one of its "observation instrument" cells, and as one line was often used by several batteries, each had to wait its turn—perhaps for 30 or 35 minutes.

All telephone wires were carried as air lines, and were often cut by shells or inimical Chinese. There were no special "command lines."

A. H. SCOTT.

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REVIEW.

MODERN ARABIC STORIES, BALLADS, PROVERBS, AND IDIOMS.

By COLONEL A. O. GREEN, *p.s.c.*

By the publication of this book Colonel Green has done a good service to students of the Arabic of modern Egypt. Those who took up the language about the beginning of the British occupation of Egypt, expended much time and energy which would have been saved if this work had then been on the market. The same applies to Colonel Green's *Practical Arabic Grammar*, which unfortunately did not appear until after many had already, through much labour, overcome the principal difficulties which meet one when first studying the language.

The present work contains an admirable selection of stories, together with literal translations. These translations are so accurate that there is no difficulty in recognizing at once which English word corresponds with which word of the original. There is also an interesting selection of poems and songs, and a valuable collection of proverbs and idioms (also with good translations).

The writer of this review has spent some little time in looking for mistakes or misprints, and has not succeeded in finding any. It is very unusual to find such a high degree of accuracy in a grammar or text-book of any language.

Perhaps a suggestion may be made for the improvement of the next edition, viz., that the system of transliteration should be stated letter by letter, so that the reader may at once ascertain with certainty which Arabic letter corresponds to each letter in the text. For this the author refers to his *Practical Arabic Grammar*. Probably most of those who read the stories will also possess the grammar, but they may not have it at hand. Moreover the author states that he has made "slight modifications" in his method, without saying what these modifications are.

Also, if one wishes to find the translation of any phrase in the middle of a long story, it is difficult to do so. This could be obviated by numbering (say) every tenth line in the text and showing corresponding numbers in the translation, or else by dividing both text and translation into short corresponding paragraphs.

It is a duty to endeavour to criticize the work under consideration in a review, but in this case it seems only possible to find the above minor points, as to which improvement might be effected.

Both the *Practical Grammar* and the *Modern Stories* are quite indispensable to anyone who is taking up modern Egyptian Arabic, and wishes to learn that difficult language with the smallest expenditure of time and trouble.

'A.M.M.'

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NOTICES OF MAGAZINES.

FRANKFURTER ZEITUNG.

A FOREIGN CRITICISM OF THE TERRITORIALS.—The issue of the *Frankfurter Zeitung* of 21st August contains an interesting article by "An Old Prussian Officer," entitled "The Difference between Volunteers and Territorials." The author claims a good acquaintance with the British Army, both in the days of the Volunteers and now. He urges, as justification for his article, that here and there the opinion exists that in spite of the South African War absolutely none of the defects in our Army have been altered. "I admit that I myself, after attending the English manœuvres, inclined to this opinion, but I must emphasize the fact that my observations there only extended to the active English Army, and not to the Territorial Army—the creation of the Minister for War, Mr. Haldane."

After expressing a most unfavourable opinion of the late Volunteers, and eulogizing Mr. Haldane for the thorough way in which he had dealt with a difficult question, the author proceeds to describe what he saw on a visit to one of the Territorial camps. The model orderliness in camp was particularly noticeable, and as regards the work, he says: "In front of the camp, under the supervision of numerous officers, the Sapper recruits were busied with laying the field telegraph or finding breaks. In the camp itself was great activity. At one spot the young soldiers (sappers) were having instruction in riding on quite exceptionally good horses, the only fault perhaps being that it was too difficult for the men, many of whom were barely 17. Of course things didn't go as with old and Regular soldiers, but it seemed almost incredible that these young fellows, who were drilled till they dropped, had mounted a horse for the first time only six days previously. While these men—sappers, mark you—were instructed in riding, in another part of the camp a detachment was practising signalling. Other men were being trained in driving. Whoever was not actually training was on camp duty; nobody was idle. There was no question of sparing them, but of curses, shouting, or abuse also no sign. The picture was most instructive, and the English have really no cause to withdraw the camps of their 'Terriers' from the foreigner's eye. These camps would do credit to any army."

It may be asked, he adds, how the preservation of such model discipline did not cause greater difficulties. In the first place it is to be ascribed to the circumstance that the "Terriers" are really willing youths. They would, besides, find themselves nowadays exposed to

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heavy punishments in the event of any signs of insubordination. Even the insignificant fact of their being dressed in the comfortable khaki in place of the old variegated uniforms contributes, according to the writer's idea, to the military bearing of the men. The chief reason is however to be found in the fact that the men are treated strictly and on a proper system. The messing is excellent. The relations between superiors and subordinates could not be better.

An army which works like this, says the writer, must succeed. "Of course an annual camp of a fortnight will not be able to produce Regular soldiers, but I am firmly convinced that the 'Terriers' will become, what Mr. Haldane wishes to see made of them, a second line, in which the Regular Army will have an excellent reserve. . . ." The large proportion of officers might surprise one, but it must be remembered that the officers require equally the training, and therefore as many as possible are taken. "After carefully considering all the circumstances, I should think that England has never been nearer her goal of producing an army fit for active service than she is to-day."

E. G. WACE.

KRIEGSTECHNISCHE ZEITSCHRIFT.

1908.

THE RÔLE OF RAILWAYS IN MODERN WARFARE.—In modern warfare, says the writer, there are four distinct uses for railways:—

(i.). For the local mobilization of army corps at their respective headquarters. To ensure the maximum of efficiency, all details for such concentration must be carefully worked out in peace time by the staff and railway officials. Railways will be required not only for the army, but also by the navy, to bring the latter up to war strength in men and coals; this fact must be remembered when working out the mobilization schemes.

(ii.). To concentrate the divers army corps on the frontier preparatory to a combined advance into the enemy's country—which in this case is assumed to be either France, Russia, or Austria. For this purpose several completely independent lines are required, each one of which is given over to one particular unit. There is no more recent example of this use of railways than the war of 1870–71, for in the Russo-Japanese War the Russians had only one line available, whilst the Japanese had to use sea transport. A consequence of this use of railways is that the modern general is somewhat tied in his movements to the line he will make use of, and consequently a careful study of any possible enemy's railway lines in peace time will repay the student should war break out with that country.

(iii.). To carry provisions and men to the army and carry back wounded.

Although many other means of transport, such as animals, heavy motor cars, mechanical transport, and even light railways, may be used,

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the permanent line will always be the chief means of transport for an army in the field, and this was proved in a small way in the recent war in S.W. Africa. Again, the necessary siege train to besiege any forts, or *forts d'arrêt*, must need be brought from the base by the railway.

(iv.). For the movement of troops in any operations on interior lines. The writer here points out how very useful railways would be to Germany in the event of a war against both France and Russia, and concluded by remarking that the object of his article is to lay stress on the enormous importance of railways in any modern operations.

FIELD FORTIFICATION IN THE RUSSO-JAPANESE WAR.—This article is a review of several others which have appeared in Russian military journals, and especially of Colonel Tschernik's "Personal Impressions on Certain Questions in Field Fortification by One who went through the War." The decisions arrived at are briefly given as follows:—

(i.). As a general rule, isolated redoubts, which are surrounded with obstacles and have a good field of fire, as well as the trenches close to them, are preferable to a continuous line of trenches with a few points of support; the former must however be able to provide good cover against artillery bombardment previous to the infantry attack. Thus, in his opinion, a completely enclosed entrenchment is still of use in the firing line.

(ii.). Having regard to the rapid rate of fire attainable with modern weapons, the firing line can be weakened and the reserve increased. One man to every two or three paces is regarded as sufficient, and where increased fire effect is desirable, machine guns can be used. The best place for the latter is between the redoubts, and placed a little in rear of the actual firing line.

(iii.). Deep digging must not be overdone in order to conceal a situation; firstly, because men firing from a low command have a restricted field of fire, in which the slightest folds of the ground hide the enemy; and, secondly, because of the difficulty of concealing the excavated earth. If this concealment is not well carried out, it at once betrays a position.

(iv.). The old lesson, that when a village is occupied well-concealed trenches must be dug in front of and near the village, was paid no heed to. The occupation of the edge of the village should only be carried out when the enemy has no high-explosive shell; the Russian quick-firers had only shrapnel. Any convenient building in the village may be used as a keep, so long as it is well concealed, surrounded by obstacles, and not exposed to high-explosive shell fire. For this reason, later in the war, earthworks were used instead of existing buildings.

(v.). So essential is concealment, that all means of obtaining it are fair. The Japanese made use of false positions, and also of sham guns and puffs of smoke like discharges from mortars to deceive the Russians as to their real position.

(vi.). When Q.F. artillery is firing from behind cover, it must make use of special observation posts and of field telephones to connect these to the battery.

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1909.

Reinforced Concrete in Military Constructions.—This article begins by showing that to resist the impact of projectiles it appears to be necessary to reinforce concrete in three directions—lengthways, breadthways, and vertically. It then enumerates the well-known advantages of reinforced concrete, and gives the compositions recommended by Professor Drushinin and Colonel Shitkewitsch. The advantage of reinforced concrete from a military point of view, namely that for the same thickness as steel it is four times as strong, is pointed out. For magazines, for piles, for hollow pipes, to serve as drains or mine galleries, for underground casemates or wells, as well as for such supplementary and indispensable buildings as slaughter-houses, gas-producing establishments for balloons, bakeries, cookhouses and stores, and last, but not least, for armouring battleships, reinforced concrete is pronounced to be the proper material; but, remarks the writer, this material only presents all the above advantage if perfectly laid.

A New Airship.—The Danzig Technical High School is designing a new airship on the rigid (Starr) system. The principal difference between this ship and Zeppelin's is that wood instead of aluminium is to be used for the framework. By this means it is hoped to avoid any electrostatic charges or discharges, with the accompanying dangers due to sparking.

Pioneer Manœuvres in Japan.—In September, 1908, important pioneer exercises were carried out, at which all officers of the Engineers who took part in the Siege of Port Arthur were present. The exercises lasted 14 days, and their importance was shown by the presence of such high military officials as the War Minister, Chief of the General Staff, and the Inspector of Staff Duties. In all probability these are but experiments preparatory to the production of a new manual of field fortification.

Other articles are:—The carriages of new high angle fire guns; the new regulations for the foot artillery; the new drill manual for the foot artillery; and an article on a new projectile.

Transport Regulations (*22nd August*, 1908).—This official manual divides transport up into baggage, columns or convoys, and trains. By baggage is meant what we generally design as 1st and 2nd line transport. It is divided into the fighting baggage which always accompanies the unit, and which now, in the case of infantry, engineers, and heavy artillery, includes one field kitchen per company, and into the heavy baggage, or 2nd line transport. Baggage is an integral part of the units themselves, whereas columns and trains are allotted to army corps or reserve divisions only. Columns include ammunition and gas columns. The latter are for the use of the balloon sections. Gas is transmitted from the columns to the section by the exchange of empty gas-containing vessels for full ones. The column also carries repairing materials and a spare balloon, which can be handed over to the sections if wanted.

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Trains include transport and supply columns, remount depôts, field hospitals, bakery sections, and the corps bridging train.

The last-mentioned unit belongs partly to the transport troops (corresponding to our A.S.C.) and partly to the engineers. It is commanded by a captain of the transport troops ("train"), whilst the escort is commanded by an engineer officer. The escort is composed of pioneers.

After the trains come the various line of communication trains, manned by transport troops. This manual also deals with the reserve transport battalions, reserve and central remount depôts, and gives plans of the suitable camps or bivouacs for various units.

MACHINE GUNS WITH FIELD ARTILLERY.—Experiments are to be carried out by the 8th Field Artillery Regiment, of the 20th French Army Corps, on the eastern frontier, with a view to seeing how far machine guns, permanently attached to batteries, can replace an infantry escort on the march as well as when in position. It is however pointed out that a machine gun can at the best but strengthen and not replace infantry, as it lacks the latter's offensive power and its adaptability to any position.

AIRSHIPS.—Pictures of the Baldwin airship of the U.S.A. Signal Corps and of the "Nulli Secundus" are given. The maximum speeds of the former during its official trials at Washington were 18 and 21 miles per hour. It can carry two men, one to attend to the machinery and rising apparatus, the other to steer. A description of the "Nulli Secundus" is also given.

A. H. SCOTT.

June, 1909.

THE DISTANT AND CLOSE ATTACK IN FORTRESS WARFARE (*continued*).—*The Close Attack.*—The close attack may be considered to have begun when the attacking infantry has established itself within about 800 yards of the girdle of works forming the main line of defence. This implies that the artillery of the attack has established a certain degree of superiority over that of the defence, but it by no means follows that the latter is destroyed, or even silenced.

In the days of smooth bore guns it was usual for individual guns to engage in a sort of duel—with the idea of dismounting each other by a lucky shot—and the actual destruction of the enemy's artillery might be reasonably hoped for, as each gun offered a good target.

But as long ago as 1870, it was found that such a result was no longer possible, and that better results would be obtained by endeavouring to destroy the gun detachments rather than the guns. To-day it is possible, by concentrating the fire of several batteries upon one hostile battery whose position can be accurately located, to put the guns out of action in a short space of time, but, as a rule, they will only be temporarily silenced. In a well-organized fortress there will be alternative positions in rear to which such guns will be withdrawn, as it is of the utmost importance to the defence to preserve his artillery for the stages of the close attack.

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The main defensive position will have been very badly chosen if it does not greatly increase the difficulties of the attack when attempting a further advance, for presumably not only will the ground over which the attack must advance be more thoroughly swept by fire, but also at this period the lighter Q.F. guns of the defence will also come into play. To reply to these it will be necessary for the attack to establish an artillery position within perhaps 1,000 yards of the girdle of defence works. This position will be covered by the attacking infantry, and a large number of guns must be established there.

The further the infantry advances, the more difficult will it be for the long-range guns in rear to continue their fire, and consequently heavier work will be thrown on the field guns in advanced positions.

As the attack draws in, the infantry of the defence must redouble their activity. They will all of course be provided with casemates or some such form of cover, but they must be ever on the alert and ready to leave these and occupy the fire trenches even under the hottest artillery fire, as otherwise they may be too late to ward off an assault.

The Japanese, in the close attack, attempted at first a rapid assault, but were compelled finally to resort to a regular approach by sapping and mining. There may however be occasions when this is not necessary, and much will depend on the activity of the defence and their skill in the use of the rifle.

Thus at Strasburg the French possessed in their rifle a weapon which, properly handled, could have developed such a fire over the foreground up to the first parallel, as would have compelled the Germans to resort to sapping. This is proved by the fact that the French sailors—who formed a portion of the garrison—handled their weapons so well that the Germans in front of them were compelled to take to sapping. But elsewhere the same skill and vigour was not forthcoming.

In general however it must be expected that, in the close attack more than in the distant attack, a systematic approach will have to be resorted to, and the labyrinth of trenches and zigzag approaches will grow more and more like the system in vogue in Vauban's time.

The existence of these numerous covered approaches and positions is likely to cramp the ardour of the attack, and to make the infantry unwilling to leave the shelter of the trenches for a sudden assault. This must be carefully guarded against, and cover in the attack must be only resorted to when absolutely necessary, and then it must be regarded as merely temporary protection, to be abandoned as soon as the slightest opportunity occurs for the employment of more rapid and vigorous means of advance.

The advanced positions of the defence, and also the intermediate works and trenches in the main girdle of defence, are suitable objectives for a less deliberate form of attack; but the manner of attack in each case will vary according to the *rôle* played by the works which are the objective.

Advanced posts, for example, in the vicinity of the main line of defence are generally occupied with a view to fulfilling some definite object, such as bringing fire to bear over folds in the ground which are concealed from the main works. They must not offer any great cover to the attack

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should they be captured; neither must they collectively form a connected line which the attack could utilize as a fresh infantry position. They will be usually of low command, but well provided with obstacles. The method of dealing with them will usually be by an enveloping attack, which will overwhelm the comparatively weak garrison.

An example of this is given by the Russian works in front of Erhlung-shan and Sungschushan, which were captured by the Japanese in their first assault on the 26th October, 1904, and at once connected by communication trenches with their approach works.

The works in the intervals between the forts and redoubts of the main position, present quite a different problem as they have no exposed flanks, are closely supported by the forts themselves, and their design, as regards size and shape, has not been subordinated to the fortified works in rear, as is usually the case with advanced posts.

However different and varied these lines of intermediate works may be in arrangement and strength, they may present any of the following common features:—(1), The garrisons will be amply provided with cover during the bombardment; (2), they will be strongly supported by both artillery and machine gun fire; (3), there will be a strong line of obstacles in front of them, which will be effectively enfiladed from the forts or redoubts. In the latter case, the truth of which must be ascertained by careful reconnaissance, a direct assault on the intermediate works only will be generally inadvisable, as the forts or redoubts of the main girdle will then be able to deliver, unhindered, a heavy enfilade fire along the obstacle, thus greatly increasing the difficulties which the attack will experience in passing it.

Even if the pioneers in advance of the assaulting troops have succeeded in cutting gaps for the storming columns, success can hardly be looked for unless the gaps are so wide and numerous that the assaulting troops can advance on a broad front.

Narrow gaps in the line of obstacles compel the assault to be made in deep columns, and these—subjected at once to a heavy frontal and enfilade fire—are sure to be swept away.

In such a case a simultaneous attack on the fort and intervals is necessitated, though the former may be only in the nature of a feint provided it suffices to fully occupy the attention and activity of the garrison of the fort. The attack of one of these forts, or supporting points, needs far more preparation than the attack on the intervals, because in a fort every means is employed which may increase its power of active or passive resistance.

There will be a double tier of fire, as it must be assumed that the covered way—so long neglected—will now be utilized as a line of defence, and made tenable by provision of overhead cover.

Suitably sited casemates will assist the rapid occupation of fire positions at the proper moment. In front of the ditch, which will be enfiladed from counterscarp galleries and thus cannot be passed till the latter are destroyed, and in front of the covered way, will extend an obstacle of considerable depth which will be protected from the fire of the attack by being sunk in a ditch, but which will be exposed to a grazing fire from the rifles, machine guns, and Q.F. guns of the defence.

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Before the assault is launched it is essential that this obstacle should be destroyed or removed, as the troops will be quite unable to remove it during the assault itself.

Formerly it was thought that, if the storming columns were provided with the necessary tools and appliances, this work of destruction could be carried out by the stormers themselves, but it is now recognized that this is quite impossible under the heavy fire from the defensive works. It was also thought that the heavy artillery fire of the attack would be able to destroy the line of obstacles—which usually consists of a belt of wire entanglement—by their high-explosive shells, or at any rate to damage it to such an extent that but little would be left for the pioneers to do; and also that the escarp and counterscarp of the ditch could be breached by the same means, so that the tedious process of mining would be unnecessary.

Consequently of recent years no system of countermines was employed in the construction of forts and permanent redoubts.

In fact the general opinion was that no work would remain storm-proof after being subjected to a heavy bombardment from the attacking siege artillery, and that an assault could always be delivered as soon as the attacking infantry had reached within some 300 yards of the works.

The Siege of Port Arthur has proved beyond all doubt that these ideas are entirely wrong.

With regard to the German Army, the author proceeds to question whether it is sufficiently supplied with siege troops and appliances to counterbalance the failure of the artillery to obtain the results expected of it. He states that the pioneers are only trained in fieldworks and bridging, and the old science of sapping and mining has been completely neglected. He points out that troops for such purposes cannot be immediately improvised, as the Prussian experiences before Strasburg clearly showed.

The training of technical troops for siege warfare was considered quite unnecessary in Germany until their pupils, the Japanese, met with their bitter experiences at Port Arthur; and though troops are now trained in this branch of warfare, the author seems to doubt whether they are fitted in numbers or skill to cope with the heavy work which will fall on them in future wars.

The most important question to which an answer is required, is whether under normal circumstances it will ever be possible to launch a successful assault against a modern permanent work from a distance of 300 yards or so.

The desire to bring the siege to a rapid conclusion by a bold and skilful assault, instead of allowing it to drag on for weeks and months, is thoroughly justifiable. Even very serious losses should not deter a commander from such a step, if success is really likely to crown his effort. But a direct assault against a work whose defensive strength is hardly impaired can only succeed when the *morale* of the garrison is of a very low order; in every other case it must fail. The assault on the Perches Redoubts before Belfort in 1871 and the Japanese assault at Port Arthur in August, 1904, are instances of this, characterized by faulty recon-

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naissance on the part of the attack and the possession of unimpaired storm-proof works by the defence.

The greater the distance at which the attack attempts its reconnaissance, the greater will be the difficulties to be overcome and the smaller the resultant fruits. At Belfort, owing to the alertness of the garrison, practically no result was obtained.

Even if the reconnaissance of the obstacles to be surmounted is successfully carried out, it is still a matter of immense difficulty to surmount or remove them, and, until the obstacle is removed, an assault promises no success against a valiant defence. Usually therefore recourse must be had to a deliberate siege approach by sapping and mining. During the progress of such an approach the assistance given by the artillery of the attack diminishes in proportion to the progress made by the attacking infantry, as the fire cannot be maintained against the defence works without great risk to the attacking troops.

The further back the position of the siege artillery is, the greater will be the risks from this source, and therefore the great distance at which the attack begins nowadays is all to the disadvantage of the assaulting troops in the last stages.

For this reason some means must be substituted for the support of the artillery at this stage; of what such means will consist is not yet quite clear, but from the experiences of Port Arthur, it seems likely that a largely increased use of hand grenades will be the main feature.

It seems strange that artillery fire should be replaced by the use of such rough-and-ready projectiles, whose efficiency depends entirely on the muscular strength and accuracy of aim of each soldier, yet in other ways as well it is not unlikely that the resources of bygone days will be resuscitated for the siege warfare of to-morrow.

In general, during the close attack the pioneers will give far more assistance than the artillery, and as the attack progresses the work thrown on the pioneers will increase proportionately, while to the infantry will fall the duty of keeping down the fire of the defence and covering the pioneers.

The endeavour to capture the covered way and also to cross the ditch will frequently give rise to a simultaneous advance both above and below ground, as it is only by the latter method that the counterscarp galleries can be destroyed and the ditch crossed.

The pioneers in both the Russian and Japanese Armies showed themselves so unskilled in mining during the Siege of Port Arthur, that all European Powers have profited by the lesson, and are making serious efforts to educate their troops to the required standard in this branch of military science.

Thus the close attack on a modern well-designed and well-equipped fort will undoubtedly consist of a covered approach by sapping and mining; and one of the most marked results of this will be that the *rôle* of the sapper will become of greater importance than that of the gunner, and, according to the author, the silent and hidden work of the engineers underground will at length receive the recognition which has hitherto only been given to the more noisy and visible results of the artillery.

C. OTLEY PLACE.

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Nature.

Latitude Observations in Polar Regions (*p.* 339).—To an explorer situated at one of the poles of the earth the stars appear to pass round him in circles parallel to the horizon once in 24 hours, and the altitude of any one star is the same at whatever time it may be taken, provided the atmospheric conditions remain constant. If the explorer could be at either pole during the winter months, the best proof he could have that he had really reached 90° latitude would be by observations of the stars. Should he be able to measure the altitude of a star with a sextant and artificial horizon at not less than 35° above the horizon, and repeat his measurement every three hours during one complete rotation of the earth, and find the altitude to be the same at every observation, he would certainly be at the extremity of the earth's axis. Effects of refraction, which is very uncertain in high latitudes, would be eliminated.

Although it is usually daylight when the explorer reaches his highest latitude and the stars are not visible, much the same plan could be followed with the sun. The sun will pass round him in a circle in 24 hours, and the only change in its altitude will be due to its change in declination, which is given in the Nautical Almanac for every hour. Should it be found then during a series of observations of the sun extending throughout 24 hours, or over a number of hours, that the observations changed just the amount of the sun's change in declination for every hour, the observer would certainly be at the pole.

As regards observations for time taken at or near the poles, the ordinary method of taking sets of altitude of east and west stars fails altogether, for the simple reason that the altitude remains practically the same at all times, and it is impossible to state the *exact* instant of time corresponding to a certain altitude. To get a satisfactory result it would be necessary to use a theodolite firmly fixed for taking transits of the sun or stars. As all meridians converge at the pole, there can be no difference of longitude. An observer exactly over the North Pole would be facing south whichever way he turned.

With a sextant and artificial horizon observations taken at a low angle, such as 10° or 11°, are unsatisfactory. In the first place, it is extremely difficult to make a contact at all, and then the image in the artificial horizon is usually greatly distorted, especially when a glass plate horizon, silvered only on the back, is used. For accurate observations a transit theodolite is necessary, but unless a solid foundation is available on which to place the instrument or the artificial horizon for the sextant, dependable results cannot be procured.

To take advantage of the best condition of the ice and to ensure a safe return, a polar explorer endeavours to reach the highest latitude at an early date, when the sun's declination is only a few degrees. Thus Nansen reached 86° 12′ N. on 7th April, 1895, and on 25th April, 1900, Capt. Cagni reached latitude 86° 34 N.; while Peary and Cook, who have lately claimed to have reached the pole, both made their furthest north in the month of April.

The meridian altitude of the sun would at the pole on 6th April be only 6°, and on 21st April about 11°, and this would not furnish an exact

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latitude, even if taken with a first-rate instrument under favourable climatic conditions, much less so when these are not favourable, and when the observations are made with small portable instruments, which alone can be carried by the explorer on his rapid dash to the Pole.

As regards the effect of extreme cold on the refraction correction of the altitude, it may be noted that for an altitude of 11° there is a difference of 1′ for a change of temperature from + 50° to – 60° F.

Sextant observations taken with a glass plate horizon on moving ice would not be trustworthy, for in addition to the probable sources of error above referred to, there may be slow oscillations of the water, tidal or other, that may considerably affect the level of the reflection surface.

W. E. WARRAND.

REVUE DU GÉNIE MILITAIRE.

August, 1909.

THE ENGINEERS AT CASABLANCA.—The conclusion of a previous article. A description is given of the work carried out at Casbah-ben-Ahmed and Settat. Native labour was substituted for military labour as soon as possible, so as to free the troops for employment with the mobile columns. Although no native labour could be obtained at first, it was very soon forthcoming when the Moors discovered that the French paid them fair wages, and treated them well. The Moorish carpenters and masons proved themselves skilled workmen, though the latter had a rooted objection to bonding their walls together. The employment of native labour by the engineers was largely responsible for the establishment of good relations with the native population generally.

MILITARY KITES.—The conclusion of a previous article. The writer deals with the subject under the following headings:—Bridles and the inclination of the cable. Influence of the construction of the kite on the method of fixing the bridle. Altitudes attained by kites lifting a cable. Groups of kites. Launching a group of kites. Lifting power of kites

September, 1909.

THE WORK OF THE ENGINEERS IN THE HAUT GAIR REGION IN 1908.—This article is supplementary to one dealing with the same subject which appeared in a previous number. The French found wire entanglements especially useful in warding off the enemy. After one attack 28 dead Moors were found in a narrow strip of entanglement outside a French blockhouse. The French also used sharpened pickets, boards full of nails, broken glass, and inundations. No information is given as to the utility of these obstacles. A course of loose bricks and large stones was placed on the top of the blockhouse walls, so that anyone attempting to scale the wall would pull the bricks and stones down on his head.

Three fougasses were dug and loaded. A short length of wall was built

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over one fougasse, in the hopes that the enemy would congregate behind it. The Moors however held off, and the fougasses were not fired.

The wire entanglements were hung with bells made out of bottles, with the bottoms cut off. Sparklets served for bell tongues. Hand grenades were constructed by lashing together two melinite cartridges, with a detonator and safety fuze attached. Attempts were made to construct grenades that would burst on impact, but these failed, owing to the indifferent quality of the detonators. Flares were prepared by wrapping a stone in palm fibre. When required for use they were soaked in paraffin, lit, and thrown by hand. They burnt for about 10 minutes, and gave an excellent light. Flares of a more permanent nature were made by tarring the fibre. These were difficult to light, had not much illuminating power, and obscured the foreground with their smoke. They were eventually discarded in favour of the paraffin flares.

The walls of the Moorish houses are about 2′ thick, and are made by ramming mud between two planks, which serve as a mould. These walls are absolutely bullet-proof. The most economical method of destroying the Moorish towers was to cut a groove on the inside of the four walls to a depth equal to one-third of the thickness of the walls. A charge of melinite was then placed in the groove in each wall, and all four charges were fired simultaneously.

J. E. E. Craster.

Revue Militaire des Armées Étrangères.

July, 1909.

The Austro-Hungarian Imperial Manœuvres of 1908.—One of the most noticeable features of these manœuvres was that on one side three different languages were used—German by the active army, Hungarian by the honved Hungarian units, and Serbo-Croatian by the Agram (13th) Division. The army and army corps commanders issued orders in German which were translated into Hungarian or Serbo-Croatian by the staffs of the divisions which used those languages. The troops taking part in the manœuvres were distributed as follows:—

The Red Force, under General Fiedler.—2 army corps = 4 divisions and a cavalry brigade, 1 independent infantry division, 1 cavalry division.

The Blue Force, under General Albori, had the same strength and organization.

The composition of the larger units was:—

1 army corps = 2 infantry divisions, 2 pioneer companies, 1 bridging train, 1 telephone section, and 1 cavalry brigade or cavalry regiment.

An infantry division = headquarters, 2 brigades of 3 to 4 battalions each, 3 squadrons, 1 artillery brigade (= 4 gun and 2 howitzer batteries), 1 section of infantry telegraphists, 1 field ambulance, 1 supply convoy.

A cavalry division = headquarters, 2 brigades (each of 2 regiments with 6 squadrons per regiment, 1 troop of mounted pioneers, 1 section of

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cavalry telegraphists), 1 machine gun section (4 M.G.'s), 1 cyclist section, 3 horse artillery batteries, 1 bridging train, 1 telegraph section, 1 field ambulance, 1 supply convoy.

An army = headquarters, 2 army corps, 1 infantry division, 1 cavalry division, 1 balloon section, 1 telephone section, 2 wireless telegraphy stations.

The strength of the units was:—Infantry company, 110 to 120 men; 1 squadron, 100 to 120 sabres; field artillery battery, 4 guns; machine gun sections:—Infantry, 2 guns, cavalry, 4 guns; balloon section, 6 officers and 100 men.

Ammunition was served out at the rate of:—Infantry, 70 rounds per man; artillery, 20 rounds per man; pioneers, 5 rounds per man; machine guns, 5,000 rounds per gun; field artillery, 100 rounds per gun; howitzers, 96 rounds per howitzer.

The repartition of the artillery on these manœuvres was an experiment, the object of which was too see if corps artillery could be done away with and the extra guns allotted to the divisions. The proportion of pioneers—2 companies per corps—was also an experiment. Great care was taken to aid rapid communication, as is seen by the large number of telephone and telegraph units. Each field artillery battery also possessed trained telephonists and 9 kilometres of cable.

Cyclists and motor cars were also used to keep up communication. Rewards in money were given to cyclists who proved to be especially efficient as scouts.

Mechanical transport was used by the western group (3 infantry and 1 cavalry divisions) of the Red Force to bring supplies to the regimental transport. A special car to supply petrol, and one to execute repairs were employed.

To supply the above-mentioned troops there were used:—5 petrol road trains, each of 1 engine and 2 to 3 carriages; 15 to 20 steam lorries of different sorts; 2 steam road trains for heavy loads over definite stages. All these vehicles belonged to the War Department.

Cars and motor bicycles were also allotted to the divers headquarters as follows:—Directing staff, 6 and 2; each army corps, 3 and 2 (1 per division); each independent division, 1 car; each independent brigade, 1 motor bicycle. The owners were compensated (1) by getting free petrol; (2), by an allowance of 6 krone per diem for each motor bicycle and 30 to 40 krone per diem per car for 10 days (1 krone = about 11d.).

Field kitchens of 27 different patterns were used. As a result of the manœuvres, it is stated that their place is with the 1st line transport, immediately behind the ammunition.

The wireless telegraph stations each consisted of 5 wagons; 2 for the apparatus and generator, 3 for the mast, and detachment. The mast was 40 to 50 metres high, and a station took two hours to erect, which is considered too long.

The manœuvres lasted three days, and showed that the army was in an excellent state of training, marches of 40 to 45 kilometres being made by some regiments, the casualties being only 1 to 1·5 per cent. The honved units proved to be as efficient as those of the regular army.

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Military News of Divers Countries.

Austria and Hungary.—Each infantry company will soon receive telegraphic, telephonic, and signalling stores, which include:—1 microphone, 1 battery of dry cells, 1,500 metres of cable, 4 flags, and 2 lanterns. They can be carried by three men.

At the end of 1909 the Austrian Government, which is in treaty with the Austrian Dirigible Balloon Club, will possess (1) a Parseval balloon—capacity 1,800 cubic metres; (2), a Lebaudy balloon—capacity 3,000 cubic metres. The War Office has moreover bought a large tract of land near Vienna, where a shed and gas works will shortly be erected.

The greyish-blue field service dress adopted by the infantry and honved units in the autumn of 1908, will in future be worn by generals, staff officers, the artillery (field, mountain, and fortress), the survey department, and all officers except those of the cavalry.

Belgium.—The first military dirigible, "la Belgique," was finished in June, 1909. Its capacity is 2,800 cubic metres, and the strength of its motor is 120-H.P.

In spite of a deficit of 5,000 men in the peace and 15,000 in the war establishments, the Government is not disposed to introduce universal military service.

Germany.—Experiments were made at the Musketry School, near Jüterborg, on the effect of infantry fire on a captive balloon. The balloon, a "Drachenballon," 12 metres long, was at a range of 1,150 metres (measured with a telemeter). An infantry company fired 4,800 rounds at it in 5 minutes, with elevations of 1,100 and 1,200 metres. The men fired in sitting or kneeling positions. As this fire had apparently no effect, an instructional machine gun company fired off 2,700 rounds in 2½ minutes with equal lack of success. The total hits was 76.

Italy.—Third report of the Royal Commission of Enquiry. (1). The Commission advise three years' service in the mounted units instead of two, and only one year for certain classes. (2). The question of breeding horses is gone into, and a better stock of stallions recommended. The use of motor cars for transport is advised. (3). The Commission report that the veterinary inspection needs reorganization. (4). The military dowry is abolished, but officers are not to be given leave to marry before 25 years of age.

A. H. Scott.

Rivista di Artiglieria e Genio.

August, 1909.

Apparatus for Examining and Measuring the Properties of Explosives.—In the above review Dr. Mettegang, who is attached to the *Carbonit* manufactory of explosives at Hamburg, gives a description of an apparatus which he has invented for the examination and measurement of the properties of explosives.

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In the preface of a work explaining this apparatus, he first of all describes the idea which led to its construction. For more than 20 years, in fact since he was first engaged in the production of explosive material, he has found the absolute want of a convenient system of analysis of the material, and of an apparatus for establishing the different characteristic qualities. A certain number of instruments existed for determining in a complete manner the efficacy of the different explosives, but they made no distinction between statical and dynamical effects. Moreover, they were not adapted for establishing the difference between materials differently constituted, and besides this some of them were of use only when applied to materials of somewhat the same kind.

The process of an explosion is somewhat as follows:—

When a solid body is capable of instantaneous ignition (or detonation), owing to some cause such as detonating capsules, shock, percussion, or high temperature, the phenomenon takes place in a very short time, which differs with different explosives. There is always however an extraordinary elevation of temperature, and a tension of the gaseous and vaporous products which is proportional to their temperature. Also a part of the products may still remain solid.

A certain time is required for the complete transformation of the solid products to gases and vapours during the detonation, and the speed with which this transformation is completed is called the "velocity of detonation."

After the products of ignition are formed, they remain for a short time only in the conditions of high temperature above described. The solid products, as well as the gases and vapours, cool down to the temperature of the surrounding atmosphere. The temperature and the greatest tension of the products of ignition can only be obtained by practice. The highest temperature should theoretically be at the moment of complete decomposition, that is at the end of the first phase of the process of explosion, and the greatest pressure should also occur at the same time.

However, at the commencement of the formation of the gas, a cooling influence from the surrounding atmosphere begins to be exercised, and consequently there is a diminution in the greatest theoretical pressure. The two phases of the process are intermingled, but this does not prevent the measuring of the more interesting elements, especially of the velocity of detonation and the greatest pressure.

The first phase of the process is, without doubt, dynamical; the second phase may be considered as statical if the moment of theoretical rest is allowed for, which exists at the instant of greatest heat and greatest tension preceding the successive phases of slow cooling of the products. Also the first phase of the process of explosion takes place with great vehemence. Black powder exploded by a detonating capsule in a closed receptacle has a velocity of detonation of 200 to 300 metres per second. In so-called explosives of security, the velocity varies from 2,500 to 4,000 metres, whilst dynamite, with slow detonation, has a velocity of 4,000 to 5,000 metres, and other kinds even attain to a velocity of 9,000 metres.

From this it will be seen that the most important characteristic of an explosive is its velocity of detonation. The maximum pressure is also

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important in a lesser degree, as its effect is disguised in the dynamical work of the shock which precedes it.

The following points are therefore of importance :—(1), The composition of the products of ignition; (2), the distribution under solid, liquid, or gaseous form; (3), the highest temperature; (4), the sensibility of the explosive to shock; and (5), the length and duration of the flame.

Apparatus for Measuring the Velocity of Detonation.—A cylinder, capable of rotating rapidly by means of an electric motor, has a toothed wheel soldered on to it, and connects with an endless screw, carrying an index placed above a scale divided into 100 parts.

The number of teeth of the wheel is equal to the number of millimetres in the circumference of the cylinder. So that when one tooth of the wheel marks a gradation on the index, it corresponds with the movement of 1 millimetre of a point on the surface of the cylinder. By means of the index therefore the movements of the cylinder can be approximated to 0·01 millimetre, which, of course, admits of the valuation of very small periods of time. In fact, it is claimed that measurements of $\frac{1}{3}$ of a millionth of a second can be appreciated.

The cylinder is blackened, and at a very short distance from it are two platinum points, each of which is attached to one of the poles of the bobbin, its other pole being attached to the axis of the blackened cylinder. The wires of the first bobbin connect with the source of electrical energy, traversing a series of incandescent lamps (which form the resistance), and passing each to the extremity of a tube 3 metres in length, which contains the explosive to be experimented with. There is also an instrument for measuring the velocity of rotation near to the motor which drives the cylinder.

If the cylinder is now rotated at 50 metres per second and the chosen explosive is placed at one end of the tube and ignited, the explosion breaks the wire of the primary circuit, and produces in the secondary circuit a current which emits a spark between the corresponding platinum point and the blackened cylinder. After a very short time the second wire breaks, and there is another spark, two points—the traces of the sparks—being left on the blackened cylinder. As a matter of fact, instead of two points only, there is a series of consecutive points, owing to the oscillatory manner in which the electricity is discharged. The distance apart of the sparks is clearly defined on the rapidly rotating cylinder, and from this the velocity of detonation can be calculated. For instance, suppose that the marking measured 20 millimetres. The velocity of rotation being 50 metres per second, 0·0004 second would intervene between the production of the two sparks, and this therefore is the time for the transmission of the explosion from one extremity of the tube to the other. The length of the tube being 3 metres, the velocity of detonation of the explosive is $\frac{3}{0{\cdot}0004} = 7{,}500$ metres.

Measuring the Pressure.—This measuring instrument consists of a chamber for the explosion and an indicating apparatus. The "chamber for

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explosion" consists of a strong steel cylinder, with an internal capacity of 15 litres, and a weight of explosive of 100 grammes, and a density of charge of 1/150. Explosives of greater density could not be used without damaging the apparatus.

As the cooling due to the internal walls of the cylinder may affect even so limited a density, this inconvenience is remedied by introducing blocks of steel within the cylinder, so as to vary the internal superfices, whilst leaving the volume unaltered.

The chamber for explosion is closed with a cover, and has two apertures, one for the indicating apparatus and the other for an insulator, through which passes one of the wires of the detonating capsule.

The "indicating apparatus" consists of a drum, round which is wound a band of paper or card. This drum is made to revolve by means of an electric motor, and a registering pen is connected with the explosion chamber, and is also in contact with its surface.

To measure the pressure developed by an explosion, 100 grammes of the charge is placed on a light tripod in the centre of the chamber. To this is fixed the detonator, from which wires pass to the commutator. The ignition of the charge is made by means of an electric current of sufficient tension. The current passes first by the commutator—which is necessary, as in the last passage of the current one of the wires leads to the explosion chamber—and thence to the earth. For greater safety a red incandescent lamp is interposed in the circuit. This signals the passage of the current and acts at the same time for the resistance. One of the two wires passes to the explosion chamber, and the other to a point isolated above the drum register, and from this point through the insulator to the detonator in the explosion chamber. The passage of the current takes place only when the drum has acquired the requisite velocity of rotation. During the rotation a small point fixed on the drum touches the pen of the isolated index, allowing the current to pass to the detonator and causing the explosion.

Before the ignition, the explosion chamber is securely closed with a cover. The cord or tape wound round the drum is kept in position by two gummed strips. The drum is now placed in position, and the arm of the register is regulated so that the pen comes lightly in contact with the card. The velocity of the drum, which is rotated by an electric motor, is measured by a chronometer, and also by means of signals of electric contact which are produced in the axis of the motor.

After the explosion the diagram is removed from the drum and measured. The pressure, as shown by the indicator, depends upon the quantity of the explosive, the volume of the chamber of explosion, and the superfices of its cooling walls. The best results are obtained by using a chamber of 20 litres, and reducing to 15 litres, the influence of the cooling superfices having been eliminated, as stated above, by the introduction of one or more steel blocks.

A description is also given of an apparatus for measuring the sensibility of the shock, and of another apparatus for measuring the length and duration of the flame.

EDWARD T. THACKERAY.

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